LANDSAT Follow-on Investigation #22510
Type II Progress Report #1 - 1 June 1975

The Use of LANDSAT DCS and Imagery in Reservoir Management and Operation

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The first three months of our participation in the LANDSAT Follow-on Program have involved continuation of our assessments of the separate and coordinated uses of satellite data collection and imaging systems for flood control reservoir management and operation.

The imagery portion of this investigation will be accomplished primarily by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire. Dr. Paul Bock of West Hartford, Connecticut, Co-Principal Investigator of our ERTS-1 project, is being retained in the follow-on investigation as a consultant.

Coordination meetings were held on 18 March and 9 May at Waltham, with personnel from the New England Division (NED), CRREL and Dr. Bock present. The next meeting is scheduled for 6-7 August at CRREL.

Location listings of our operating DCP's as of 6 June follows. Please note changes from the list submitted with our ERTS-1 Final Report. Also note that CRREL continues field experimentation with two DCP's, both now in Alaska.

DCS data relay from NASA via our real time teletype link continues with a nominal lag of 45 minutes. Punched cards and computer printouts usually arrive by mail within a week of data acquisition by NASA. We are still recording and analyzing DCP, sensor and battery performance and reliability.

LANDSAT-2 - DCP INFORMATION SHEET
ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION 6 JUN. 1975

ID NO.	DCP NO.	TYPE*	STATION NAME	LAT	LONG
1	6021	S	ST. JOHN RIVER AT FORT KENT, MAINE	47 15	68 35
8	7273	S	ST. JOHN RIVER AT NINEMILE BR., MAINE	46 42	69 43
2	6355	S	PENOBSCOT RIVER AT WEST ENFIELD, MAINE	45 14	68 39
3	6271	S	CARABASSETT RIVER AT NORTH ANSON, MAINE	44 52	69 57
5	6171	S	SACO RIVER AT CORNISH, MAINE	43 48	70 47
6		S	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	43 45	71 41
7	7233	S	MERRIMACK RIVER AT GOFFS FALLS, N.H.	42 57	71 28
10	7242	S	TOWN BROOK AT QUINCY, MASS.	42 15	71 00
41	7106	S	NORTH NASHUA RIVER AT FITCHBURG, MASS.	42 34	71 47
11	7345	S	PAWTUXET RIVER AT CRANSTON, R.I.	41 45	71 27
13	7304	S	BRANCH RIVER AT FORESTDALE, R.I.	42 00	71 34
12	7254	S	CONNECTICUT RIVER AT HARTFORD, CONN.	41 46	72 40
20	7206	P	STINSON MOUNTAIN, N.H.	43 50	71 47
21	7127	P	SOUTH MOUNTAIN, N.H.	42 59	71 35
22		P	FRANKLIN FALLS DAM, N.H.	43 28	71 40
23	6042	P	BLACKWATER DAM, N.H.	43 19	71 44
24	6012	P	MACDOWELL DAM, N.H.	42 54	71 59
26	7246	P	WACHUSETT MOUNTAIN, MASS.	42 29	71 53
25		P	MANSFIELD HOLLOW DAM, CONNECTICUT	41 46	72 11
42	7010	Q	WESTFIELD R. AT WEST SPRINGFIELD, MASS.	42 06	72 38
43	7142	Q	CHICOPEE RIVER AT CHICOPEE, MASS.	42 09	72 35
44	7207	Q	FRENCH RIVER AT WEBSTER, MASS.	42 03	71 53
50		T	NED HEADQUARTERS, WALTHAM, MASS.	42 24	71 13
51	6325	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE	
52	6216	T	COLD REGIONS LAB AT HANOVER, N.H.	VARIABLE	
54	6063	T	U.S. GEOLOGICAL SURVEY, BOSTON, MASS.	VARIABLE	

* S=RIVER STAGE
P=PRECIPITATION
Q=WATER QUALITY(TEMPERATURE,CONDUCTIVITY,PH AND DISSOLVED OXYGEN)
T=TEST SET(SENSORS VARIABLE)

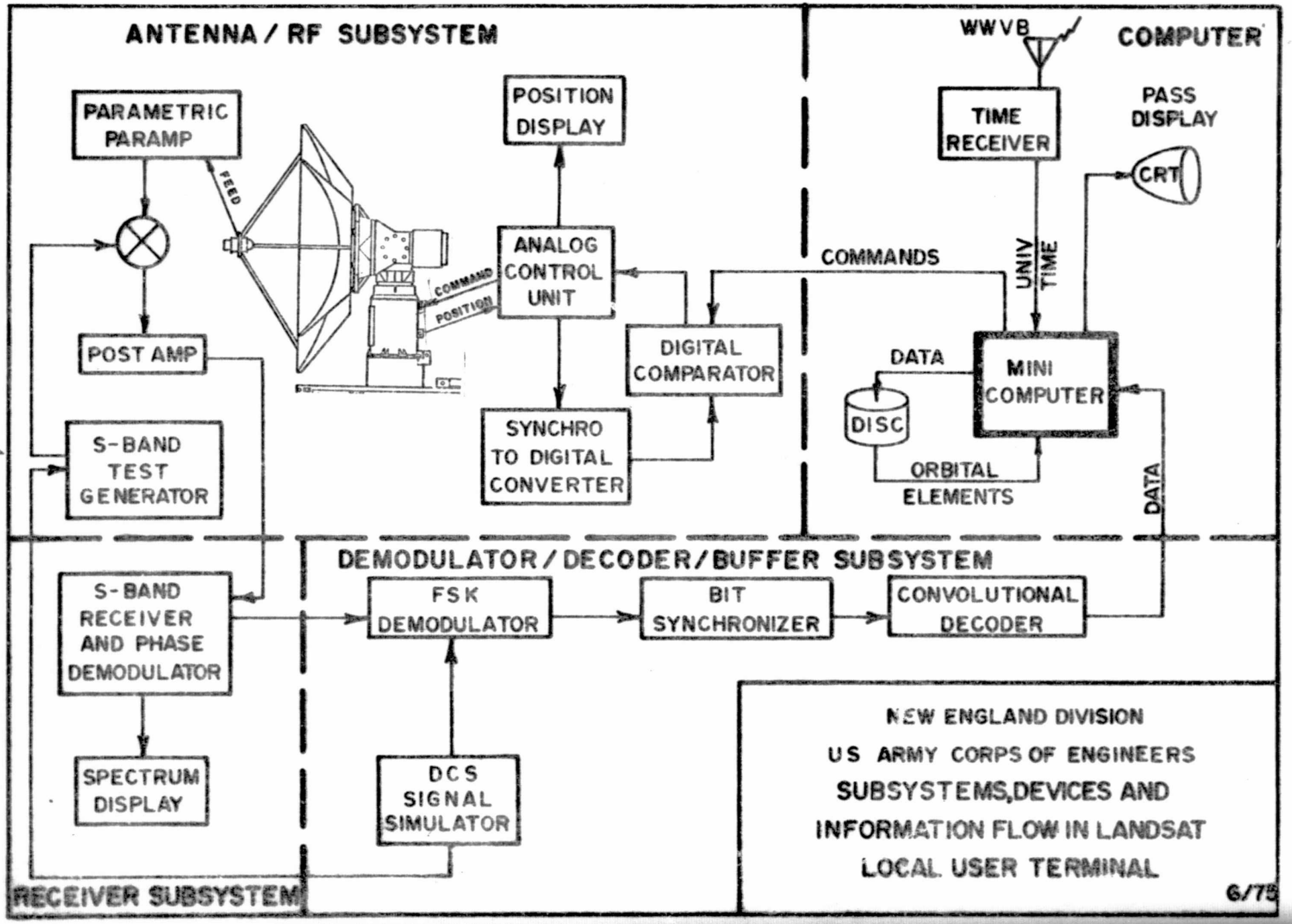
C-3

An updated summary of our statistics will be presented in a future progress report.

The LANDSAT DCS hardware is performing well. Necessary DCP repairs are currently being accomplished in a commendable and timely manner by personnel at NASA, Wallops Station, Virginia. Turnaround time usually ranges between one and three weeks.

During April and May our DCP's on the Saint John River in northern Maine provided hydrologic information for relay to flood forecasters at the New Brunswick Power Commission office in Fredericton, New Brunswick, Canada. The site at Ninemile Bridge in the headwaters of the river had, prior to LANDSAT, never been attainable for real time data acquisition. The Saint John River DCP's which in the previous two years helped to monitor and predict spring flood conditions, this year monitored high waters which only approached flood stage. In this respect we wish to express our appreciation to NASA staff members who reported DCP data on weekends by telephone to NED personnel at home, thus permitting a continuity of data acquisition and relay even during NED's non-office hours.

Construction of the direct LANDSAT DCS ground receive facility or Local User Terminal (LUT) at our Waltham Headquarters is continuing, with support from NASA and the Office of the Chief of Engineers in Washington. This will enable the NED Reservoir Control Center to receive hydrologic data from data collection platforms in the field directly at Waltham with no time delays. The software to drive the antenna system is being developed with the intention that the antenna operate in an unattended mode automatically for one or two days at a time, with a Data General NOVA mini computer controlling all processes. Several important pieces of hardware have already been acquired and tested. The antenna hardware has been shipped from NASA Goddard to Scientific-Atlanta, Inc. for refurbishing. Testing of this equipment in Atlanta, Georgia is scheduled for the week of 21 July 1975, with delivery to NED anticipated early in August. We expect that by late August 1975 the entire LUT facility will be operable in a test mode. A diagram of the system, as presently envisioned, follows.


ANTENNA / RF SUBSYSTEM
COMPUTER
WWVB
PARAMETRIC PARAMP
FEED
POSITION DISPLAY
TIME RECEIVER
PASS DISPLAY
CRT
COMMAND
POSITION
ANALOG CONTROL UNIT
COMMANDS
UNIV TIME
POST AMP
DIGITAL COMPARATOR
DATA
MINI COMPUTER
DISC
S-BAND TEST GENERATOR
SYNCHRO TO DIGITAL CONVERTER
ORBITAL ELEMENTS
DATA
DEMODULATOR / DECODER / BUFFER SUBSYSTEM
S-BAND RECEIVER AND PHASE DEMODULATOR
FSK DEMODULATOR
BIT SYNCHRONIZER
CONVOLUTIONAL DECODER
SPECTRUM DISPLAY
DCS SIGNAL SIMULATOR
RECEIVER SUBSYSTEM
NEW ENGLAND DIVISION
US ARMY CORPS OF ENGINEERS
SUBSYSTEMS, DEVICES AND
INFORMATION FLOW IN LANDSAT
LOCAL USER TERMINAL
6/75

The LUT comprises the following four subsystems:

Antenna/RF
Receiver
Demodulator/Decoder/Buffer
Computer

The antenna is made up of a 15-foot tracking dish and pedestal, and several controlling devices. Incoming data are gathered in the feed horn, amplified, and passed to the Receiver subsystem. This subsystem is in the same cabinet as the Antenna/RF subsystem and consists of the S-band receiver and phase demodulator. An S-band test generator is being procured by NED for use in routine health checks. Data proceed from the Receiver subsystem to the Demodulator/Decoder/Buffer, which is housed in the computer cabinet, and then to the Data General NOVA mini computer in BCD code.

The mini computer is a very active component of the LUT. It will periodically interrogate radio station WWVB for the correct Universal Time, control the antenna and acquire data virtually simultaneously by multitasking programs. By accurately knowing the time of day and the satellite's precise predicted position the computer will easily keep the satellite within the antenna's 3 degree receiving beam width. Current plans call for the total slave mode of operation, i.e., tracking will depend on the computer being informed correctly. However, we are also developing software autotracking packages which will be more versatile. With these, if for some reason, the satellite were outside the antenna's receiving beam, the computer would execute a search for it and order changes in antenna direction and movement to bring it back into view.

In order to limit data received to our own DCP's, the LUT equipment is being fitted with an electronic 'screen' that will admit only messages from platforms that transmit serial numbers from 7000 through 7999. To this end we are now completing the task of changing the serial numbers of all our DCP's to be acceptable to the filtering hardware. Changes to date are reflected in the list of DCP locations which appears earlier in this report.

In the imagery investigation our primary activity will be to analyze by computer techniques hydrologic parameters relevant to NED reservoir management and control functions. The ultimate goal of this will be the development of an interactive computer processing system for depicting and manipulating hydrologic data from LANDSAT imagery on a real time basis.

Of the major hydrologic features detectable in LANDSAT imagery scenes we have chosen to look first at river stage. During the period from late June to early July 1973, near record water storage heights occurred in the Corps of Engineers Franklin Falls Reservoir, Franklin, New Hampshire. A maximum of 66 percent of capacity resulted from this event. The area of the water surface at the maximum stage was recorded by a LANDSAT-1 overpass on 6 July 1973. The first task in our investigation has been to quantify the areal extent of the inundation as delineated by the imagery. Computer compatible tapes were obtained for all four MSS wave bands of the 6 July 1973 and 27 October 1972 scenes which would supply maximum and normal water surface areas, respectively. These tapes were then processed and recorded on disc and analyzed utilizing computer algorithms. A portion of the scenes was selected for detailed study, including regions both upstream and downstream of Franklin Falls Dam. Comparison of the computer maps for these shows an increase of 40 percent in water surface area from the 27 October pass to that of 6 July. During the next quarter the entire Franklin Falls impoundment area will be analyzed utilizing computer techniques, and the extent of water coverage for 27 October 1972 and 6 July 1973 will be determined. A comparison will be made to ground truth data from the NED Reservoir Control Center and the accuracy quantified.

During the recent quarter we requested 9-day imagery coverage through our Technical Monitor for the New England spring snowmelt runoff season, and the request was granted for the period 1 April through 31 May 1975.

Receipt of LANDSAT imagery from the EROS Data Center has ranged between four and eight weeks after data acquisition by NASA. This is acceptable for our current studies, but by no

means approaches the 'real time' that we would require for reservoir regulation purposes. A tabulation of the dollar value of the imagery data ordered and received through 28 May 1975 for this investigation is as follows:

Type of Imagery	Value of Data Allowed	Value of Data Ordered	Value of Data Received
LANDSAT Prints and Transparencies (standing order)	A total of $4,900	Does not apply	$1,708
LANDSAT Prints and Transparencies (retrospective orders)		0	0
LANDSAT Computer Compatible Tapes	$6,800	0	0
Aircraft Imagery	$ 360	0	0

As in our original ERTS-1 investigation, we continue to consider communication and exchange of information with others regarding LANDSAT as vital to the overall success of our participation in the program. Throughout the reporting period we have hosted numerous guests from the data collection and imagery communities interested in our progress, including representatives from NASA, the U.S. Geological Survey and Office of the Chief of Engineers in Washington.

On 19 and 20 May, Mr. Cooper attended the NASA-sponsored Satellite Data Collection User Requirements Workshop at Easton, Maryland. An article on Data Collection by Satellite, co-authored by Dr. Horowitz of this office, is in the winter issue of Water Spectrum, volume 6(4): 37-41 (copy inclosed).

The total NASA funds expended on this investigation as of 31 May 1975 amount to $354.

1 Incl
As stated

SAUL COOPER
Principal Investigator

Water spectrum

issues·choices·actions

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

Vol. 6, No. 4, Winter 1974-75

OUR TROUBLED WATERWAYS

by Maj. Gen. J. W. Morris

The requirement to dredge our navigable waterways to insure proper channel depths for shipping, and the resultant need to dispose of the dredged materials, has become a problem of great national significance. Unless we can find ways to continue the maintenance of our waterways in the face of environmental, legal and technical constraints, a situation may be precipitated which could adversely affect the entire economy.

For the past 30 years, domestic waterborne commerce, including inland barge and Great Lakes traffic, has moved almost 16 percent of the Nation's ton-miles of intercity cargo.

This inland waterway barge traffic has increased over the past 2 decades at a compound rate of slightly over 5 percent per year.

The amount of tonnage that can be moved in a single tow has increased from 5,000 to 50,000 tons per tow during that period. It is predicted that traffic on various segments of the waterways will increase from 4 to 6 times in the next 50 years. Total waterway commerce presently totals 1.7 billion tons per year—over 350 billion ton-miles—or about 7 tons per capita. This cargo is carried at an average cost of 3 mils per ton-mile.

While the freight traffic of grain, ores, chemicals and construction materials continues to increase, it is the energy-producing commodities, predominantly petroleum and coal, that comprise slightly over 50 percent of the domestic waterborne freight. As the cost of energy materials increases, it becomes more important to move them as economically as possible for the ultimate benefit of the American consumer. As the prime mover of energy supplies,water carriers are also the least consumptive—using less than 500 British Thermal Units of energy per ton-mile.

About 1/3 of total waterway commerce is with foreign countries. Raw materials and manufactured products which move through our waterway system to the export market contribute significantly to our national economic health by bulwarking our balance of payment deficit and helping to keep the dollar strong in foreign markets.

While a national view of waterway economic statistics may demonstrate magnitude, a narrower focus can be more meaningful when applied to a localized situation. At New Orleans, for example, the economic impact of the port to the local area and to the State is tremendous. The chain of economic events that starts when cargo lands at that port finally results in the employment of 37,000 people, $7 million in city taxes, $19 million in State taxes, $256 million in port-related income, and a total economic impact on Louisiana of $1.8 billion a year.

Expansion of port, harbor and associated facilities goes hand-in-hand with continued economic and population growth. In the 27-year period ending with 1972, individual ports in the U.S., Puerto Rico and Canada invested almost $4 billion in marine terminal facilities. The projected rate of annual investment for these purposes during the 1973-77 time frame is $341 million. Development of service facilities for offshore oil terminals may add another $500 million to this investment.

Thus, the viability of our economy is clearly dependent upon our ability to keep the channels of our waterways, ports, and harbors open to navigation. However, our harbors and channels are subject to shoaling and loss of depth from natural deposits of material. In order to maintain navigation we either have to limit vessel draft or remove the material blocking the channels by dredging.

This national decision involves the Corps for the following reason. Since 1824, the Corps has had a congressionally mandated mission to plan, construct, operate and maintain our waterways. During this time, the country has developed 25,000 miles of navigable channels, 107 commercial ports and harbors and 400 small boat harbors. Fifteen thousand miles of these channels are 9 feet or more in depth and, except for the upper Mississippi and Missouri Rivers and the St. Lawrence Seaway, all of the waterways are open to year-round navigation.

In order to maintain this year-round capability, periodic dredging of all channels is required. This, by itself, is a straightforward task, varied only by the methodology involved, and for 150 years dredging has been a daily activity attracting little or no attention from the public or other water resource agencies. All of a sudden, however, dredging became a dirty word and the Corps was placed in the position of being able to take the material from the bottom of our waterway channels—but without any place to put it.

When constraints are placed on the methods of disposal of the dredged material, a classic dilemma is born. Dredging is essential or shipping stops. If there is no place to put the transient real estate blocking the channel—we cannot dredge. We found the sharp horns of this dilemma gouging us more deeply each day.

So the stage was set for the entrance of the first constraint—the environment! Previously, there has been very little understanding of the national dredging program on the part of either the general public or other water resource agencies. Nor has there been any attempt on the part of the Corps to explain what essentially was a routine operation. Consequently, when the environmental alarm bells rang and "pollution" became a household word, it was understandable that concern would be evidenced when there was talk of wetlands being destroyed by dredged material placement, back channels being blocked to the detriment of fish and wildlife, and deep water areas used for placement of dredged material named "ocean wastelands."

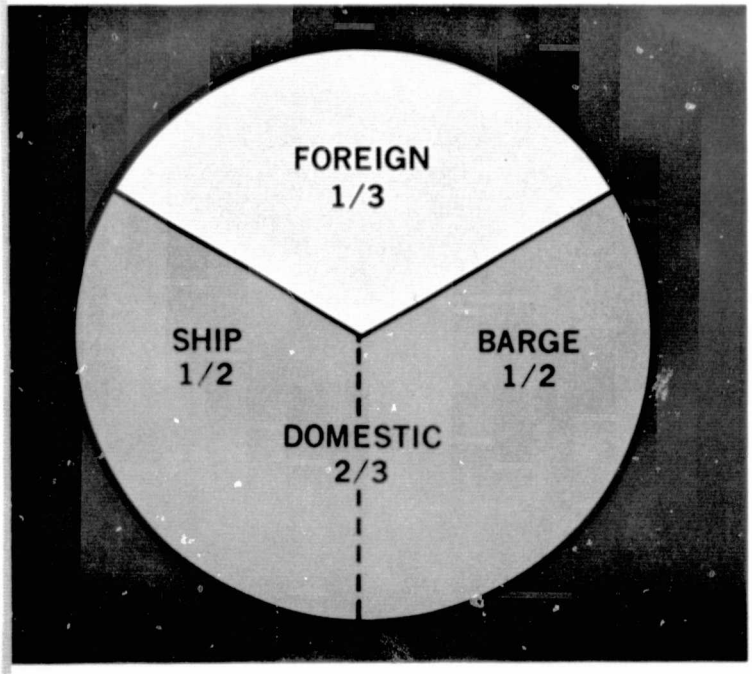
To overcome this communications gap and to develop better public understanding of the problem, it is essential to discuss openly and fully the pros and cons of the dredged material placement program, the constraints under which the Corps operates, and what is being done to rectify the situation.

There are only 4 general types of areas that may be used for placement of the material removed from the channels. These are off-channel, ocean or other open water areas, diked areas, or areas upland from the dredging site. Each has both advantages and disadvantages.

Off-channel discharge, common to our inland waterways, is highly cost effective. This consists merely of a dredge pumping the material from the bottom of the channel and redepositing it in the water far enough away from the pickup point to prevent the material from slipping back into the channel. This method has some positive benefits, in that it can extend wetland areas, create artificial islands and

Over half the domestic freight movements, such as this coal laden tow, carry energy related commodities.

About 1/3 of our waterway commerce originates or terminates in foreign countries.



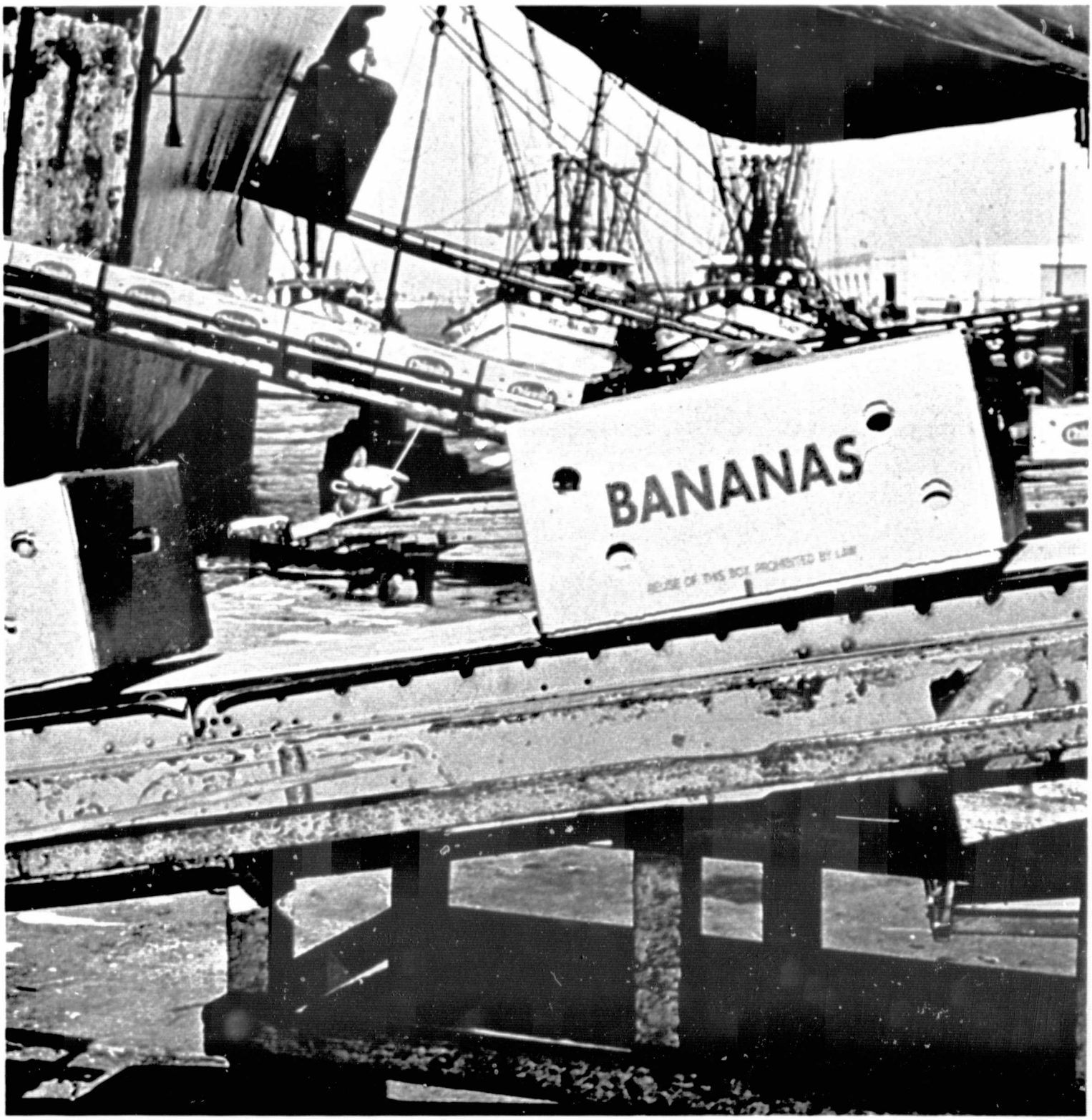
develop attractive recreational areas. On the negative side, this method of disposal causes a short-term increase in water turbidity at the discharge point for a short period, temporarily disrupts the local biotic community, and tends to cause shoaling which can interfere with lateral drainage and natural flows. In regard to the affected biotic communities, we are aware that changes do take place, but the state-of-the-art does not yet permit us to evaluate these changes quantitatively with any degree of accuracy.

This inland disposal problem is in sharp focus in the upper Mississippi River, where off-channel disposal is used extensively. The Corps has maintained navigability of this area since 1922 by congressional direction.

Maintenance dredging in the channel, along with natural accretions, has created a series of small islands which act to reduce the water surface, to narrow existing wetlands and, in some cases, to cause shoaling. This has caused back channel drainage problems. As a result, our disposal techniques have come under sharp criticism from environmental interests in the adjacent States, where court injunctions have prohibited all but emergency dredging.

Ocean and other forms of open-water disposal have always appeared environmentally acceptable and this method has been used for many years. It avoids disruption of all the natural values in the coastal zone, including estuaries and wetlands. Further, the disruptive influence it has in the discharge area is so small in comparison to the vast and dynamic influence of the surrounding waters that the net effect should be minimal. On the other hand, some marine scientists contend that the long-term cumulative effects of ocean water disposal could have serious adverse conse-

Heavy silting following flooding of the lower Mississippi effectively reduced foreign trade at the port of New Orleans by an estimated half billion dollars during the spring of 1974.



quences. Again, we simply do not know enough about the effects of open-water disposal to determine the degree of risk involved.

One approach to this problem is to dispose of the dredged material in very deep water at great distances from the shore. However, the cost of long-haul disposal increases drastically with distance. The Corps has been faced with this alternative in San Francisco Bay where constraints against traditional open-water disposal have seriously affected maintenance efforts.

This happened when other Federal agencies and the State of California adopted suggested Environmental Protection Agency (EPA) guidelines for pollution. The guidelines for heavy metals, for example, provide that dredged material containing levels in excess of those recommended should not be placed in open water. However, the natural state of certain spots in San Francisco Bay already exceeds EPA guidelines for several heavy metal pollutants. Consequently, if we pick up bottom material from these spots, we cannot put it back in the bay.

The alternative is to take this small percentage of material that exceeds EPA guidelines out to sea for disposal. However, this increases unit dredge costs and the time required for normal maintenance dredging.

Reduced dredging in some vital channels could pose a national security problem as well. Without normal channel depths, that part of the Pacific Fleet home-ported in the bay area would have to be diverted to other refitting and resupply berthing areas along the West Coast.

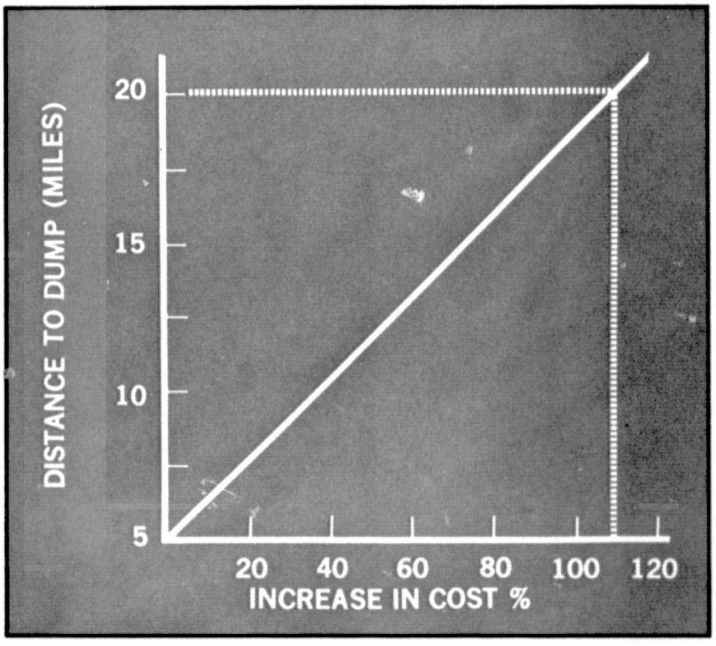
Diked disposal offers major advantages absent in either off-channel or open-water methods. This method can be used to supply land fills for industrial or recreational development. Additionally, by carefully controlling the elevation profile, diked disposal areas can be used as wetlands. One limiting factor is environmental, since diked disposal areas generally lie along a shoreline or are superimposed on natural wetlands and, consequently, are usually controversial. Furthermore, the cost is high. For instance, our diked disposal program in the Great Lakes will cost an estimated $240 million over the next 10 years. Yet this same amount of money would pay for 25 years of open-water disposal in the Great Lakes.

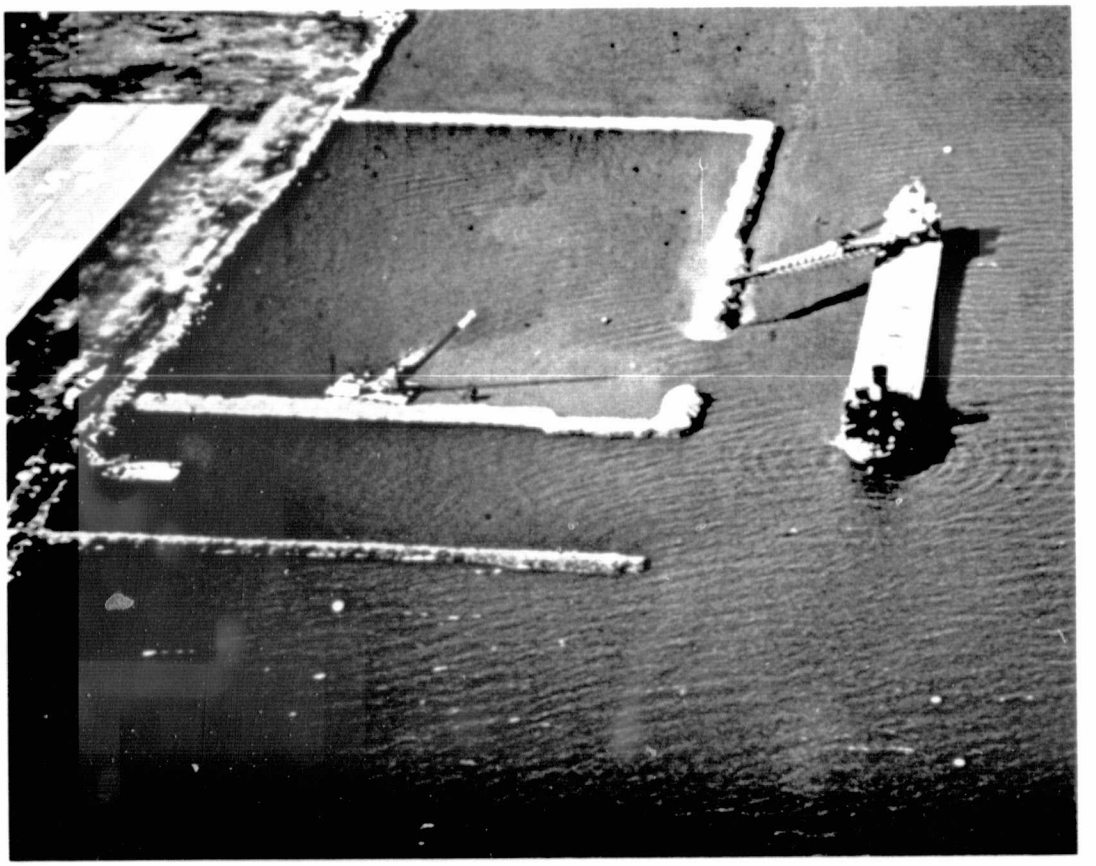
A typical problem with diked disposal can be illustrated by the Cleveland Harbor project. Dredging on the Cuyahoga River outlet is backlogged because the initial diked areas have become filled in the Cleveland area. New diked areas have not yet been completed. The delays are caused by various factors, including environmental objections to the newly selected sites. Only the currently high waters within the Great Lakes, which have increased draft depths, are preventing an immediate problem of serious magnitude.

Upland disposal, the fourth method of disposal, is often suggested as an alternative by those who find the other 3 objectionable. Unfortunately, this method also has its disadvantages because it requires that considerable real estate be taken out of the useful land inventory for a period of time. For example, a small effort such as the river channel at West Haven, Conn., involves only 81,000 cubic yards of dredged material, but it requires over 20 surface acres for placement. In high density population areas, even a parcel that small is difficult to find within economic reach of the dredges and at a reasonable price.

This method also causes some change in land configuration, some disruption of the predisposal biotic community, and almost always some opposition from landowners, communities, developers, conservationists and a host of others who disagree with the site selected for one reason or another.

Hopper dredges can dump into open ocean water, but cost of long-haul disposal increases in direct proportion to distance from dredging site.





Diked disposal can supply land fills for new development but often conflicts with existing land uses.

Dredged material placement often enhances an area so much that further use brings environmental protests. The fishing ho! Cabin Johns creek on the C&D Canal is an example.

Occasionally the Corps does such a good job of material placement that disposal sites are preempted. At Cabin Johns Creek, on the Chesapeake and Delaware Canal, we used up approximately 1/3 of our disposal capacity at that uncontested placement site back in 1969. When we returned this year to reuse the site, we found that the pond created in the upper basin had become a popular fishing place, was abundant with wildlife and enjoyed by many recreational visitors. So that site is now a valuable *natural* resource, environmentally unacceptable to use for further disposal placement.

In the legislative arena there have been several major laws enacted that impact on our maintenance effort, beginning with the Fish and Wildlife Coordination Act of 1958. Only 3 of the laws enacted since then, however, primarily affect dredging. These are the National Environmental Policy Act (NEPA) of 1969, Section 404 of the Federal Water Pollution Control Act Amendments of 1972, and Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972. The latter section is referred to separately as the Ocean Dumping Act.

Under NEPA, an Environmental Impact Statement (EIS) is required whenever a major Federal action significantly affects the quality of the human environment. On the date of NEPA's enactment the Corps had over 1,200 navigation maintenance projects, many of great scope and environmental complexity, and we had to consider initiating impact statements on them all. The administrative burden alone was rather staggering.

During the period the Corps was getting underway with NEPA, Congress passed the Federal Water Pollution Control Act Amendments and the Ocean Dumping Act. While both acts designate the Corps as the permit issuing agency responsible for authorizing dredged material discharges, they also give EPA substantial review responsibility and the ultimate decision making power in a contested action.

The key factor in each act is the requirement to provide notice and opportunity for public hearings. While this requirement has existed for construction projects for many years, this is the first time it has been applicable to maintenance work. Although primarily oriented toward permit authorization for dredge disposal by commercial entities, these provisions apply equally to Corps operations. While the Corps does not issue permits to itself, it does apply to itself (by regulation) the same criteria and procedures that are applied to other permit applicants. Of course, Corps actions are also subject to EPA review and potential denial of selected sites.

While the administrative requirements are being met with relative ease, the remaining problems involve 2 principal matters: first, the overwhelming number of impact statements that have had to be prepared; second, it now requires greater effort and time to provide impact statements sufficiently technical and legal to satisfy private organizations and other Federal agencies.

Not being able to prepare these impact statements on short notice, we established a priority for ongoing projects. Even though NEPA did not require an EIS on projects under construction prior to NEPA, the Corps made a conscious decision to include these in the belief that some change might be needed in a given project which would be beneficial to the environment.

To date, over 1,600 environmental statements have been prepared. We now have impact statements prepared and filed on all new construction work. On certain dredging projects in operation before NEPA, some of which have been underway for a century, we still have a substantial backlog. There are environmental assessments available, but no statement or negative determination has as yet been filed with the Council on Environmental Quality.

Under the previously mentioned public notice provision, those in oppostion to a project not covered either by an EIS or negative determination have a basis for legal action. In emergency situations, however, waterway navigation and dredging activities to sustain it must continue—meaning some dredging projects may have to go ahead immediately without either type of statement. Potentially controversial projects, however, have been identified and expedient EIS action is being taken to preclude work stoppage by legal injunction.

Another congressional directive engendered a constraint of an entirely different nature, which also had an impact on the dredging program. Two years ago, the House and Senate Appropriations Committees directed the Corps to undertake a study and make recommendations back to them on the proportionate number of dredging vessels required in both the Federal and private sectors. During the conduct of this study, a moratorium was placed on any additions, modifications or replacements to the Corps-owned dredge fleet.

This moratorium came at a time when decisions were needed to update a dredge fleet that had been in operation an average of 30 years and was getting continuously more expensive to operate and maintain without extensive modifications or replacement. Private contractor-owned dredge equipment was in much the same condition. In view of the moratorium placed on the Federal sector, private contractors were unwilling to make large capital investments until Congress reached some decisions.

While the Federal and private sector dredge-plant equipment has been capable of handling normal maintenance requirements, despite age and condition, emergency situations have played havoc with that capability.

Last spring, for example, because of flooding, high waters and extremely heavy silting in the Mississippi River, the entrance channel to the Port of New Orleans was reduced in depth from 40 to 34 feet. This required ships to sail in and out with less than a full load, holding some $500 million in imports and exports out of the world commerce market. To meet this crisis, the Corps had to shift both federally-owned and contractor plant equipment within the Gulf coast area and from the entire East Coast just to dredge the New Orleans channel back to normal project depth. As a result of this emergency requirement, a dredging backlog was created in other ports and harbors.

In addition to the inefficiencies of aging plant, and the higher costs of labor and materials, there are increased costs associated with more expensive disposal methods—such as long-haul ocean disposal—in trying to use equipment which is not well adapted to those methods.

Dredging costs, like the costs of all goods and services, are steadily increasing. In 1967, the cost was less than 30 cents a cubic yard for the removal and disposal of dredged material. By 1976, at the projected rate of increase indicated by all economic factors, this cost will rise to almost 60 cents a cubic yard.

At our peak in maintenance dredging we removed and disposed of 300 million cubic yards of dredged material. Compressed into one-yard cubes covering a mile square area, this amount would grow skyward at the rate of one football field length each year. Spread out, it would give Delaware a new surface, a yard deep, every 20 years.

While our ability has been declining since that peak period, the requirements have continued steadily upward and at this point-in-time we should be at the 400 million

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In the legislative arena there have been several major laws enacted that impact on our maintenance effort, beginning with the Fish and Wildlife Coordination Act of 1958. Only 3 of the laws enacted since then, however, primarily affect dredging. These are the National Environmental Policy Act (NEPA) of 1969, Section 404 of the Federal Water Pollution Control Act Amendments of 1972, and Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972. The latter section is referred to separately as the Ocean Dumping Act.

Under NEPA, an Environmental Impact Statement (EIS) is required whenever a major Federal action significantly affects the quality of the human environment. On the date of NEPA's enactment the Corps had over 1,200 navigation maintenance projects, many of great scope and environmental complexity, and we had to consider initiating impact statements on them all. The administrative burden alone was rather staggering.

During the period the Corps was getting underway with NEPA, Congress passed the Federal Water Pollution Control Act Amendments and the Ocean Dumping Act. While both acts designate the Corps as the permit issuing agency responsible for authorizing dredged material discharges, they also give EPA substantial review responsibility and the ultimate decision making power in a contested action.

The key factor in each act is the requirement to provide notice and opportunity for public hearings. While this requirement has existed for construction projects for many years, this is the first time it has been applicable to maintenance work. Although primarily oriented toward permit authorization for dredge disposal by commercial entities, these provisions apply equally to Corps operations. While the Corps does not issue permits to itself, it does apply to itself (by regulation) the same criteria and procedures that are applied to other permit applicants. Of course, Corps actions are also subject to EPA review and potential denial of selected sites.

While the administrative requirements are being met with relative ease, the remaining problems involve 2 principal matters: first, the overwhelming number of impact statements that have had to be prepared; second, it now requires greater effort and time to provide impact statements sufficiently technical and legal to satisfy private organizations and other Federal agencies.

Not being able to prepare these impact statements on short notice, we established a priority for ongoing projects. Even though NEPA did not require an EIS on projects under construction prior to NEPA, the Corps made a conscious decision to include these in the belief that some change might be needed in a given project which would be beneficial to the environment.

To date, over 1,600 environmental statements have been prepared. We now have impact statements prepared and filed on all new construction work. On certain dredging projects in operation before NEPA, some of which have been underway for a century, we still have a substantial backlog. There are environmental assessments available, but no statement or negative determination has as yet been filed with the Council on Environmental Quality.

Under the previously mentioned public notice provision, those in oppostion to a project not covered either by an EIS or negative determination have a basis for legal action. In emergency situations, however, waterway navigation and dredging activities to sustain it must continue—meaning some dredging projects may have to go ahead immediately without either type of statement. Potentially controversial projects, however, have been identified and expedient EIS action is being taken to preclude work stoppage by legal injunction.

Another congressional directive engendered a constraint of an entirely different nature, which also had an impact on the dredging program. Two years ago, the House and Senate Appropriations Committees directed the Corps to undertake a study and make recommendations back to them on the proportionate number of dredging vessels required in both the Federal and private sectors. During the conduct of this study, a moratorium was placed on any additions, modifications or replacements to the Corps-owned dredge fleet.

This moratorium came at a time when decisions were needed to update a dredge fleet that had been in operation an average of 30 years and was getting continuously more expensive to operate and maintain without extensive modifications or replacement. Private contractor-owned dredge equipment was in much the same condition. In view of the moratorium placed on the Federal sector, private contractors were unwilling to make large capital investments until Congress reached some decisions.

While the Federal and private sector dredge-plant equipment has been capable of handling normal maintenance requirements, despite age and condition, emergency situations have played havoc with that capability.

Last spring, for example, because of flooding, high waters and extremely heavy silting in the Mississippi River, the entrance channel to the Port of New Orleans was reduced in depth from 40 to 34 feet. This required ships to sail in and out with less than a full load, holding some $500 million in imports and exports out of the world commerce market. To meet this crisis, the Corps had to shift both federally-owned and contractor plant equipment within the Gulf coast area and from the entire East Coast just to dredge the New Orleans channel back to normal project depth. As a result of this emergency requirement, a dredging backlog was created in other ports and harbors.

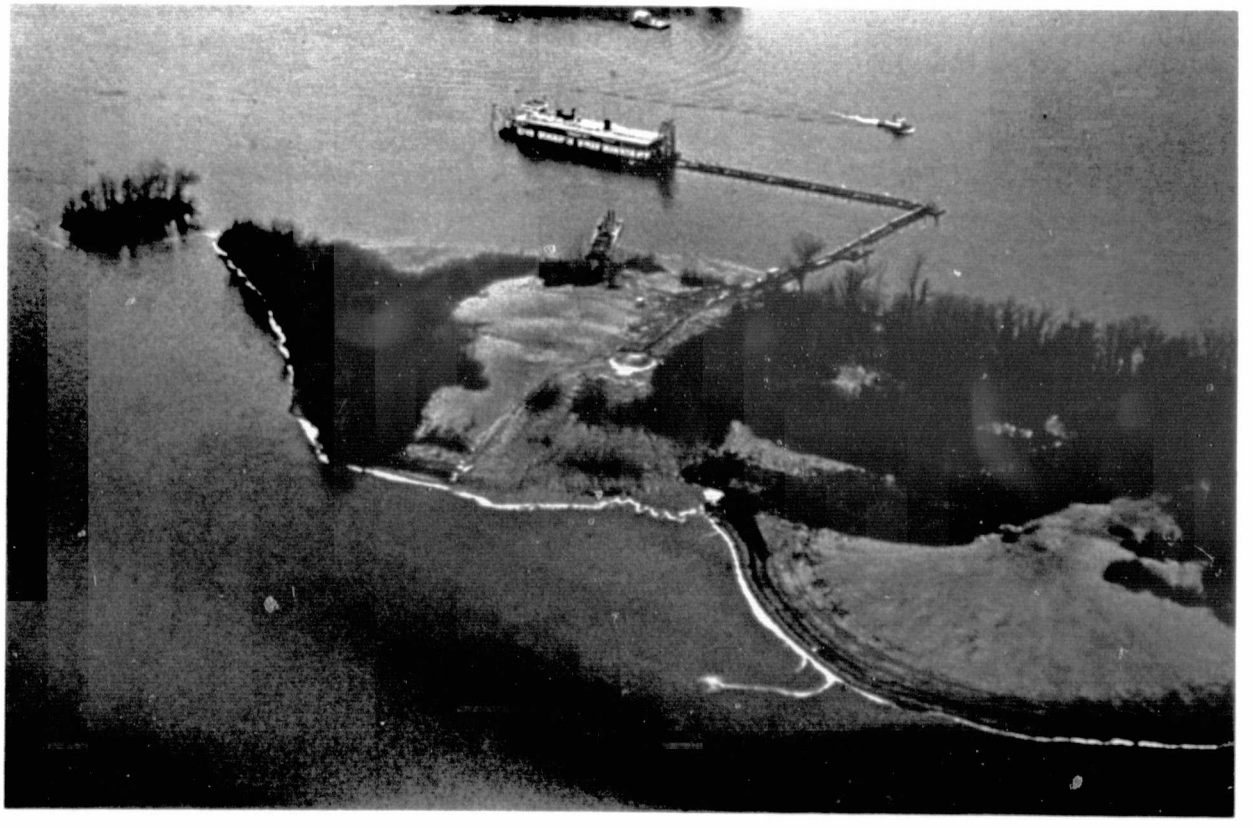
In addition to the inefficiencies of aging plant, and the higher costs of labor and materials, there are increased costs associated with more expensive disposal methods—such as long-haul ocean disposal—in trying to use equipment which is not well adapted to those methods.

Dredging costs, like the costs of all goods and services, are steadily increasing. In 1967, the cost was less than 30 cents a cubic yard for the removal and disposal of dredged material. By 1976, at the projected rate of increase indicated by all economic factors, this cost will rise to almost 60 cents a cubic yard.

At our peak in maintenance dredging we removed and disposed of 300 million cubic yards of dredged material. Compressed into one-yard cubes covering a mile square area, this amount would grow skyward at the rate of one football field length each year. Spread out, it would give Delaware a new surface, a yard deep, every 20 years.

While our ability has been declining since that peak period, the requirements have continued steadily upward and at this point-in-time we should be at the 400 million

Beneficial uses of dredged material can include recreation areas, nourishment of beaches, creation of wildlife habitats and new islands with multipurpose potential.



cubic yards a year stage for both maintenance and new construction dredging. With the current constraints our FY 1976 capability projection is just slightly above 200 million cubic yards annually.

Had each issue—*dredged material and its placement—EIS requirements—the dredge plant moratorium*—arisen separately in time, each one could have been handled individually without a major impact on our waterways. Unfortunately, they surfaced almost simultaneously and, consequently, have seriously affected the Corps' ability to maintain navigation. While the solutions have been slow in coming, the Corps is making progress.

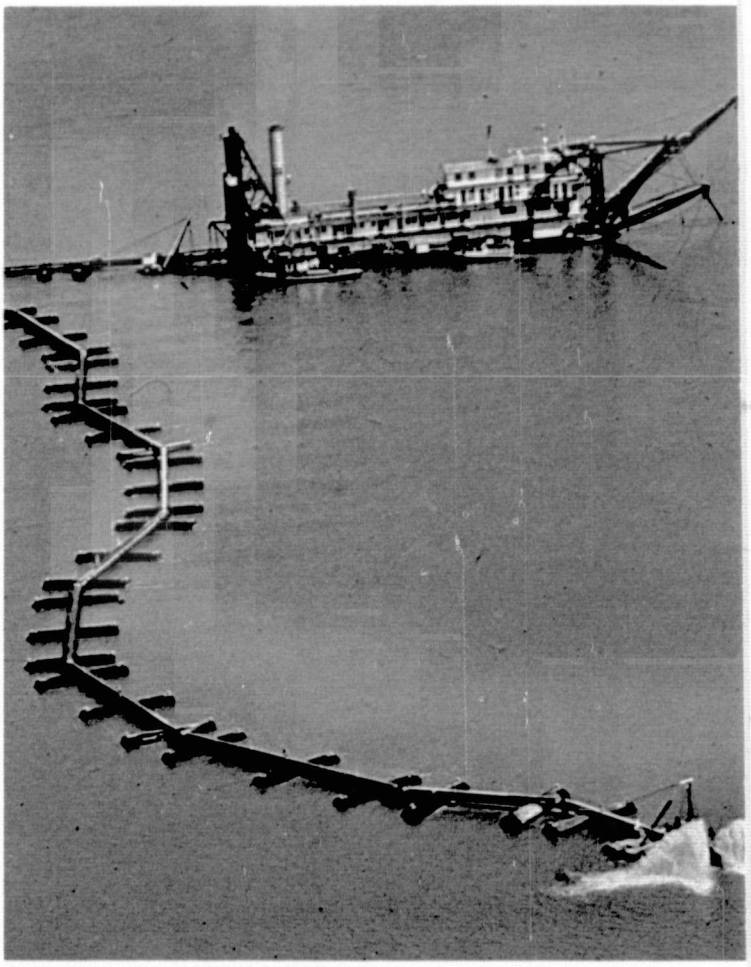
On the first issue, the Corps initiated a two-pronged attack several years ago. First, we started looking for new disposal concepts and techniques which would convert dredged material from a vexing problem into a valuable resource. Our environmental and recreational staffs have been working with our engineers to develop beneficial ways to use dredged material. In some areas we have created new wetlands, created water-based recreational areas, nourished beaches, created wildlife habitat, and created or extended highly attractive islands. (As the public and other agencies become convinced that dredged material can serve useful, beneficial purposes, the task will become easier.)

Second, we embarked last year on a 5-year, $30 million research program being managed at the Waterways Experiment Station located in Vicksburg, Miss., by a staff of experts selected from the governmental, scientific, industrial and academic communities. The object of this research is to consider dredged material as a renewable, recyclable resource and find ways to use it beneficially—develop methods of on-site testing of dredged material to determine quickly its degree of pollution, if any, and the origin of any contaminates—determine the environmental impacts of both water and land disposal—explore new disposal concepts—and to make use of improved dredging and disposal equipment and techniques.

Out of all this we should learn where dredged material is harmful and where it is not. We should learn what additional costs are justified in the interests of environmental protection. And, equally as important, we must learn enough to answer the kinds of questions that will make impact statements not only technically viable, but sufficiently authoritative to satisfy the public; a public that wants the assurance that not only will there be an absolute minimum of environmental impact, but that any change required to maintain navigation will also be mitigated as much as possible.

As to the second issue—the legal requirements—we have taken the position that with the passage of NEPA, Congress did not intend to halt all ongoing major Federal actions which might significantly affect the quality of the human environment. Had this been the case, our entire transportation network, from a maintenance viewpoint, would have become a nightmare of economic chaos. Rather, the intent was to comply as quickly as humanly possible while making the necessary adjustments to maintain navigability of our waterways in the interim. This is what the Corps is doing. We have an intensive effort underway to insure full compliance by no later than January 1976.

Our third issue—the status of the aging dredge fleet—has now passed the study stage and the final report has been forwarded to the Secretary of the Army for subsequent transmittal to the Congress. This study and our recommendations should greatly assist Congress in determining the total plant required in both the Federal and private sectors and in deciding under what conditions to lift the moratorium on Federal plant improvement. Both the Federal Government and private industry should then be able to move forward in confidence with a modernization of the national dredge fleet *and* with improvements in the operating characteristics of dredging, which are just as badly needed.

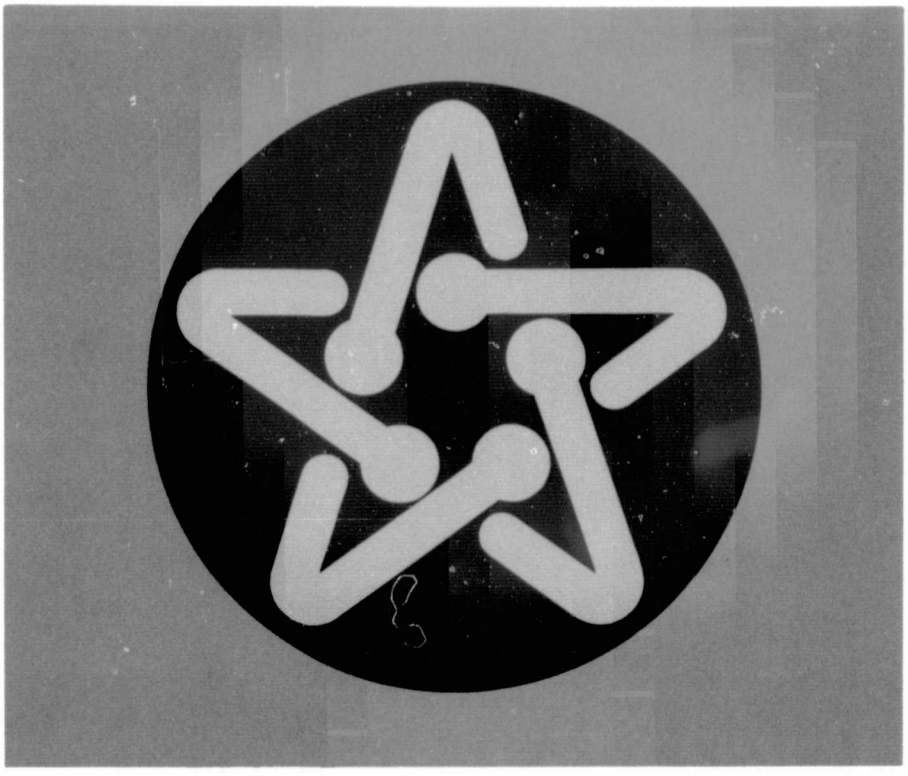


The average age of the Federal dredge fleet is over 30 years. Congress will soon be studying Corps recommendations on this problem.

The Corps' experience and organization make it well suited to continue its job of maintaining the country's navigable waterways. During this period of constraints on dredging, however, the adjustments being made will depend upon the good will of the public and the cooperation of other agencies.

The Nation needs our waterways; they are more vital to our economic well-being now than perhaps ever before. The Corps is convinced, however, that the challenge presented by dredging constraints can be successfully resolved without sacrificing environmental quality of life, in compliance with public laws, and in a technological manner superior to methods and equipment used in the past. The Corps is dedicated to pursuit of that challenge.■

Water For PROJECT INDEPENDENCE



by David Zachary Kaufman,
Federal Energy Administration

Growing energy shortages, reinforced by the 1973 *crisis*, pushed the United States into its decision to take a hard look at America's future resources. The result is the Project Independence Blueprint, a plan for the use of the Nation's future energy resources. Its title reflects its goal: to obtain maximum energy self-sufficiency by the 1980s and to reduce our dependence on foreign fuel supplies.

The Project Independence Blueprint is a comprehensive plan for formulation of a national energy policy that was created by the Federal Energy Administration (FEA), which was itself born of the Federal Energy Administration Act (P.L. 93-275) on June 28, 1974.

No sooner had FEA begun to study strategic options for meeting America's energy needs than water resources constraints appeared. It became evident that the potential demands placed upon our Nation's water resource by various energy development programs would cause severe water use conflicts in several water short regions of the Nation. Therefore, FEA decided to define alternative energy development programs for each of the 20 Water Resource Regions established by the U.S. Water Resources Council (WRC).

FEA created 9 fuel group task forces, assigning each task force to look at one or more of the following energy areas: *oil, natural gas, coal, nuclear power, oil shale, synthetic fuels, solar, geothermal,* and also those *facilities* necessary to produce or process these energy resources. In addition to studying hydropower as a separate form of energy (under *facilities*), water was recognized as a resource related to some part of the process for converting the other resources into

useful energy forms. Therefore, water usage in itself became an equally important factor within each task force's study assignment.

Task Force Reports

Each of the fuel group task forces discussed the varying needs for both withdrawal and consumption of water. Withdrawal represents water eventually returned to the source, but with varying degrees of degradation in quality; consumption of water represents water lost to the immediate environment. The task force reports can be summarized with the following comments on each energy area.

Oil and *natural gas* both require water for drilling. Wherever secondary or tertiary recovery techniques are used, however, much larger amounts of water are necessary, since vast amounts must be pumped underground to force the underlying oil or gas to the surface. Since the United States consumes approximately 17 gallons of water for each barrel of oil produced, water is intimately related to these forms of energy production.

Coal mining consumes water for several purposes. Access roads and coal surfaces being worked must be watered down for dust control in both surface and underground mines. Water is also used to wash the mined coal, transport the coal away from the mine in slurry form through pipelines, wash up by mine personnel and to help in revegetation of strip-mined areas. The amount of water consumed varies from 4 to 18 gallons per ton of coal mined, depending on the region. Water withdrawals also vary among regions from as little as 4 gallons to as much as 430 gallons per ton.

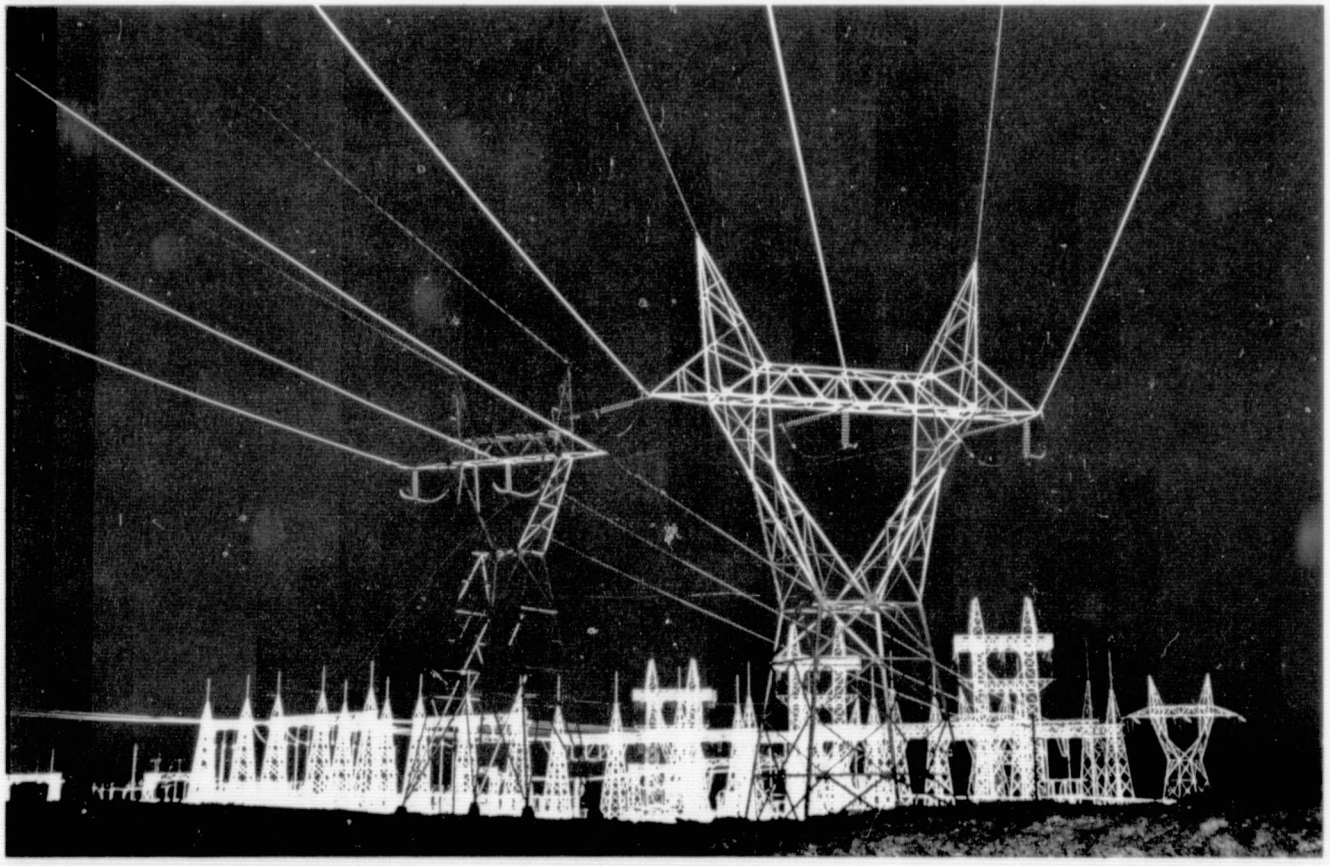
Nuclear power generation withdrawal and consumption requirements are derived essentially for cooling needs. Nuclear plant water consumption factors vary with the type of plant and cooling processes used. In general, a water consumption factor of 0.8 gallons per kilowatt hour was used by this task force to calculate regional water requirements. The mining and processing of the raw fuel—uranium ore (U_3O_8)—also requires the use of some water.

Extracting crude *oil* from *shale* with presently available technology requires large amounts of water. First of all, water is necessary in the mining and processing of the shale. Second, the oil present after retorting (distilling by heat and pressure in the presence of a catalyst) is of such high viscosity that a hydro-cracking process is necessary to upgrade the shale oil into a useful fuel. Finally, more water is needed to compact and stabilize the spent shale and to control dust. Besides these industrial uses, additional water for personal household use and related industrial uses will be required if any significant development of oil shale resources is undertaken—since large numbers of workers would have to be imported into the now sparsely populated areas of potential oil shale production. Research indicates that a plant producing 100,000 barrels of oil a day will require 16,800 acre-feet of water each year.

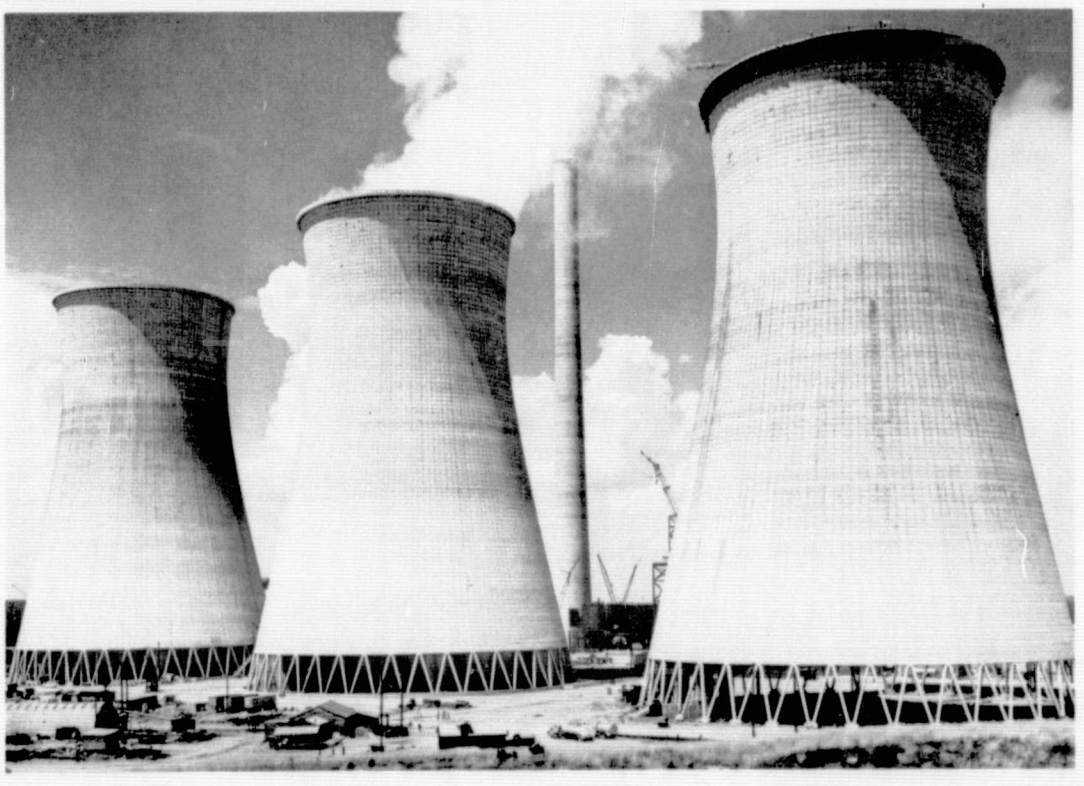
Water quality requirements for shale oil vary. Although higher quality water is necessary for retorting and upgrading the shale oil and for household use by the industrial workers to be imported into the area, spent shale disposal can be accomplished with brackish or other lower quality waters. This might be obtained from dewatering the shale mines.

Producing *synthetic fuels* from coal consumes water in

Night view of switchyard at Glen Canyon Dam on Colorado River in Arizona highlights dependence of electrical energy on nearby water supply.
Bureau of Reclamation

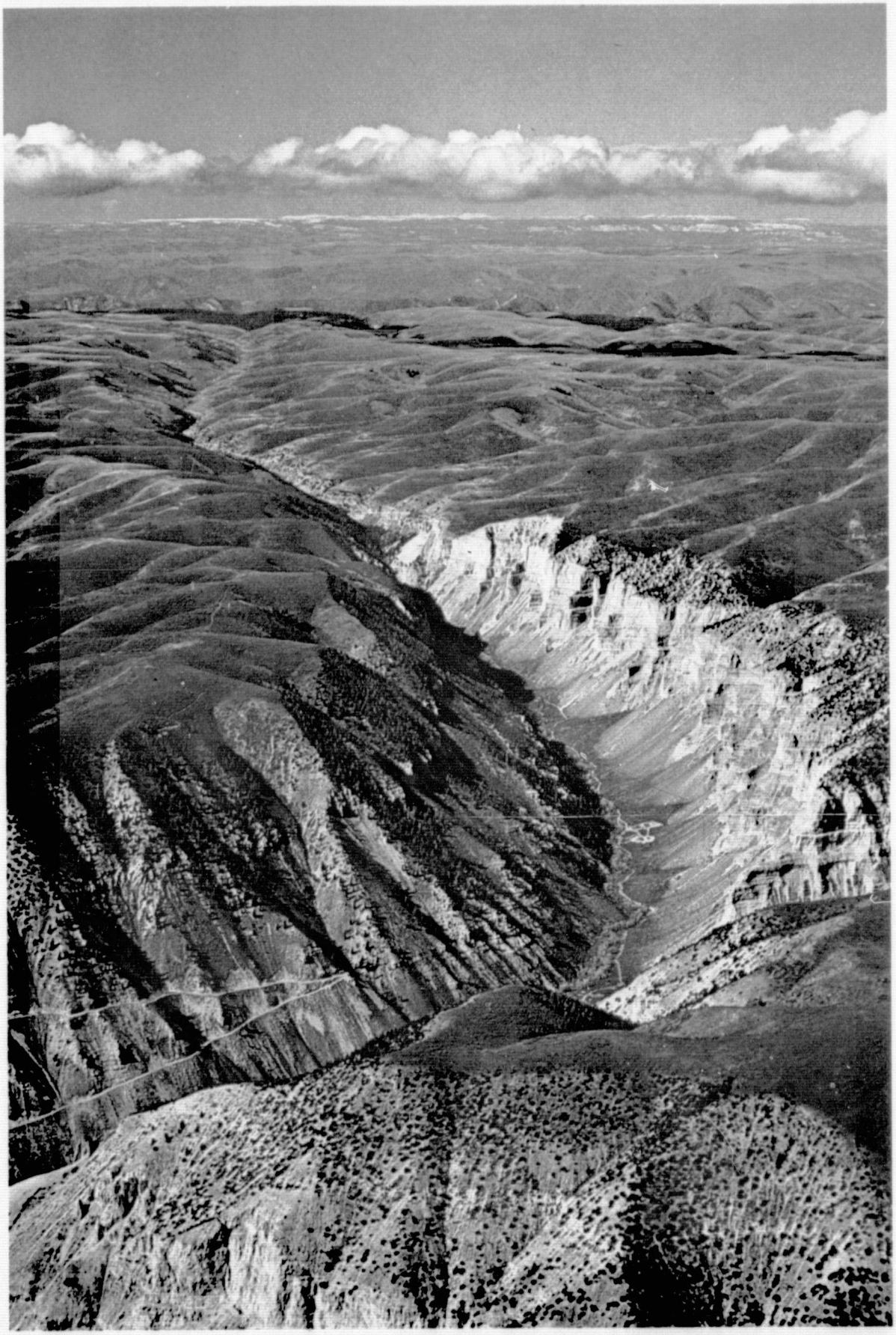


Water is consumed and used in the processing of coal for several purposes.

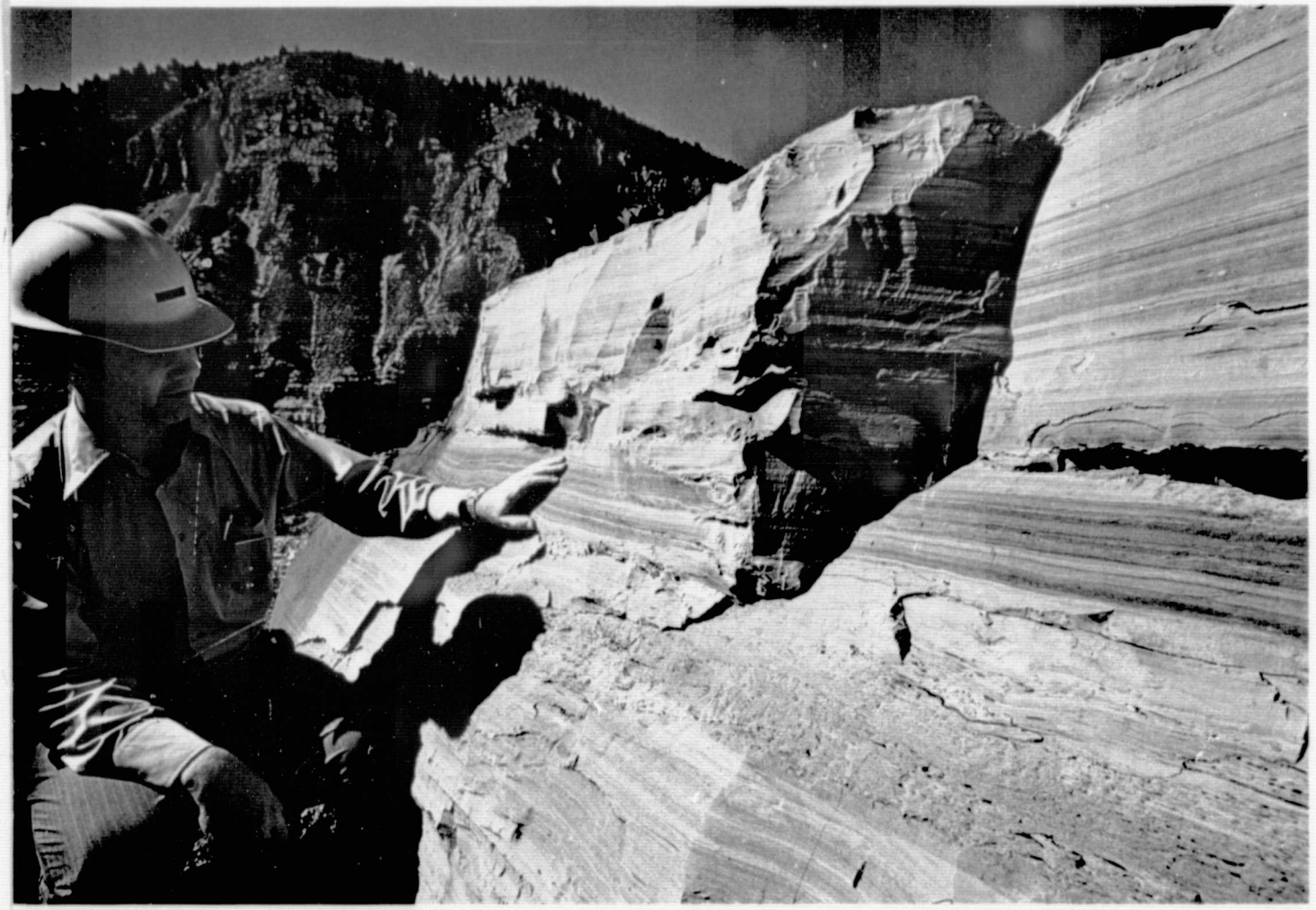


Cooling towers symbolize extensive use of water in nuclear and fossil-fuel generated electric power.

Some of the richest oil shale deposits are in northwestern Colorado's Piceance Creek Basin. Colony Development Operation



Crude oil can be mined from these layers of shale with large amounts of water. Colony Development Operation



three ways. First, water is used in the chemical processes that convert the coal into either high or low British Thermal Unit (BTU) gas or liquid fuel. Second, water is evaporated in the cooling activities associated with these processes. Third, water leaves the processing site as moisture content in the coal ash and waste discharges. Consumptive use ranges from less than 10 gallons per million BTUs for the liquid and Fischer-Tropsch processes (that produce hydrocarbons and their derivatives) to over 100 gallons per million BTUs for those processes that produce pipeline gas. Research indicates a plant capable of providing 100,000 barrels of synthetic oil daily consumes over 5,900 acre-feet of water a year.

Solar heating and cooling requirements for water are difficult to estimate. Any such estimate depends on whether the system is flushed and how often. The amount of energy saved by the system is also important. In general, water requirements for solar systems are similar to conventional water heating systems.

Geothermal water requirements for a plant using the hot water technology would be very small, probably no more than 470 acre-feet a year for a 200 megawatt (MWe) plant. There are no foreseeable water requirements for the dry steam design, since the hot dry rock technology may or may not use water as its fluid.

The *facilities* task force provided data on deep-water ports, oil refineries, conventional steam-electric generating, hydroelectric and gas processing plants. Included in this data are cost and possible production goals at a given price, personnel required for construction and operation, coefficients of material used and expected water requirements per unit of output.

This type of data is being supplied as trial scenarios for two different rates of development. The first is the *business as usual* rate, in which the Federal Government takes no extraordinary steps to encourage energy development. The second is *accelerated,* in which the Federal Government takes an active role in encouraging development of additional domestic energy sources and expansion of existing sources.

FEA Projected Requirements

At the same time as the FEA-directed task forces were starting to outline possible programs for energy development, the WRC agreed to analyze the impacts and effects of the associated water requirements. This analysis depends on prior FEA decisions pertaining to the types of energy the Nation should develop both at a given time in the future and within specific geographic regions. A computerized model provided this type of information by balancing the varying factors being contributed as data inputs from each of the 9 fuel group task forces. WRC will then analyze the associated water requirements, taking into account the available water supply within each region.

Geyser activity indicates geothermal source of energy. Bureau of Reclamation

WRC's national assessment of water supply data completed in 1968 is currently providing FEA with its estimates of potential water supply for the future. Assuming no further changes in the Nation's current storage capacity for water, FEA moved on to the next step. This was to estimate non-energy related demand for water, which FEA obtained from WRC projections for the year 1985. The latter are broken down by regions that are based on the boundaries of water basins formed by our major rivers and their tributaries.

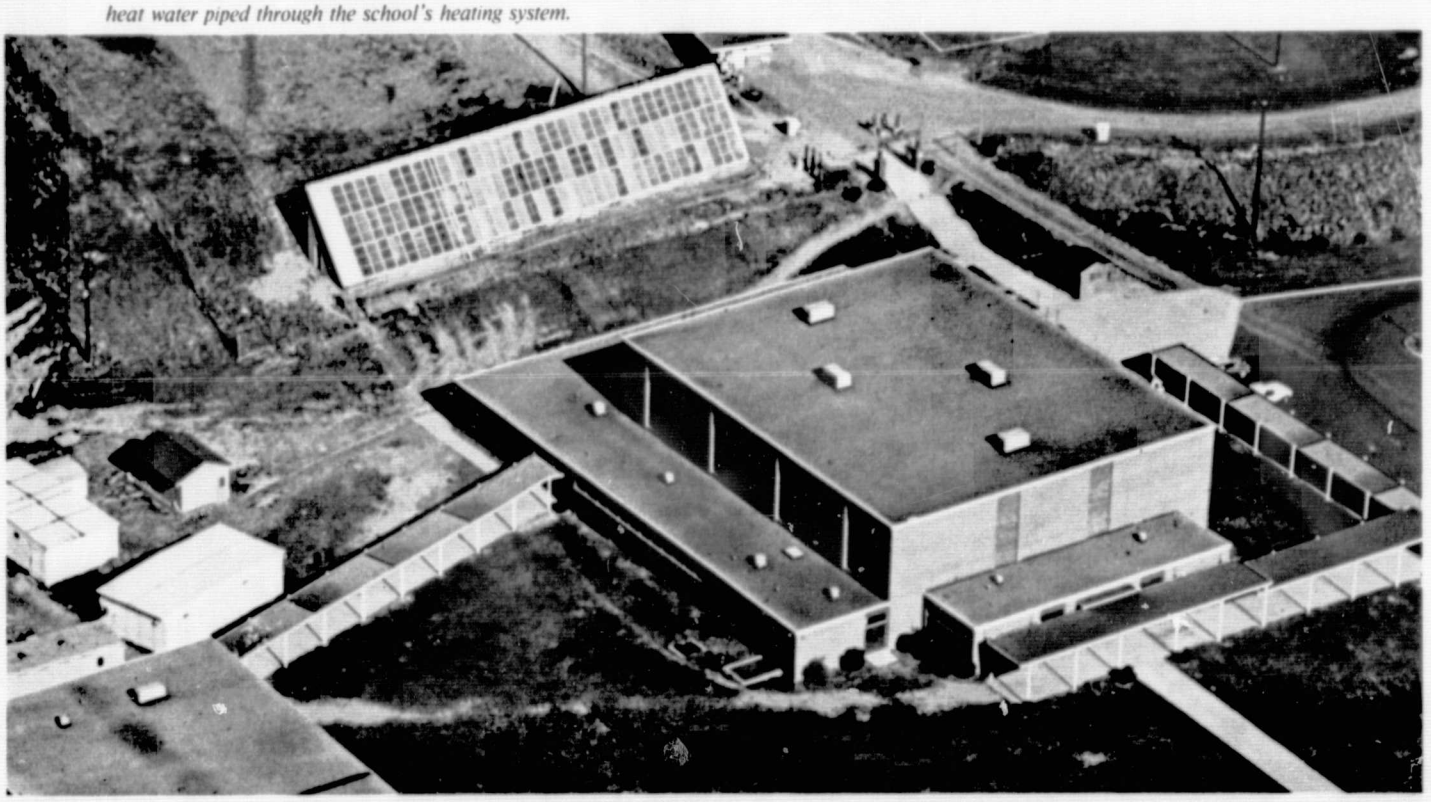
Since FEA's fuel group task forces were using their own regional breakouts for the country, FEA requested them to match their task force regions to those defined by WRC. The result was a matrix displaying the proportion of coal, oil, gas, etc. production that could be expected in each regional water basin. This action permitted FEA to relate all its trial scenarios for energy development and their associated requirements for water to the WRC regions.

The Council will then compare each FEA scenario demand with the available water supply for that region. Only those scenarios which appear to have some promise of fulfillment will receive an in-depth analysis by the Council's regional cooperators. Their comments on each in-depth analysis will be included in our Project Independence Blueprint.

The existing scenarios are based on the estimated gross water supply available for use in producing or processing different forms of energy from the natural resources present in each of 17 continental United States water regions delineated by the Council. FEA's task forces used these estimates to create trial scenarios for energy development for the years 1977, 1980, 1985 and 1990. Each year's scenario contains both the withdrawals and the consumption of fresh water incident to the production or processing of energy. The examples shown should not be construed as forecasts, since each one is derived from a set of conditions assumed only for the purpose of analysis.

Eventually, the Project Independence Blueprint will contain detailed analyses of those trial scenarios showing the most promise. Until completion of such analyses, only broad observations can be made in reference to the availability of water within specific regions of the continental United States.

Fauquier High School at Warrenton, Va. may be the world's first solar school. The greenhouselike structure at its side collects the sun's rays to heat water piped through the school's heating system.



WRC Assessment

In general the country is water-rich east of the Mississippi River and water-poor to its west—with the exception of the water-abundant Pacific Northwest. Even within the water-rich regions, though, there are localized supply problems. The Boston-Washington megalopolis and parts of Florida are examples. From an overall standpoint, however, the East will not be as seriously constrained by its lack of water supply as by the environmental problems besetting it.

For a more explicit categorization of the Nation's water resources picture, it becomes necessary to focus individually on each region. The regional discussions below follow those shown in the accompanying WRC map. These discussions do not consider the island communities of Hawaii and Puerto Rico, which have no direct impact on the continental United States.

North Atlantic

Water in the New England and Middle Atlantic States is abundant but unevenly distributed, both geographically and seasonally. Generally, surface water is of good quality, but many of the major streams are polluted. Groundwater is available and suitable for most uses.

Potential energy related developments within this region include nuclear- and fossil-fueled power plants, conventional and pumped storage hydroelectric plants, expanded and new refineries, coal mining and the use of offshore drilling for oil and gas.

Large water withdrawals will be required for steam-electric power generation. The physical plant and cooling towers will be large and there could be extensive thermal pollution due to the size of the facilities envisioned. The same is true for potential oil refineries. In addition, storage reservoir sites are limited in this region, creating severe competition for water in the metropolitan areas.

South Atlantic—Gulf

The coastal region is underlain by highly productive aquifers. Surface water quality is generally excellent and groundwater is suitable for most uses. Both ground and surface water supplies are considered adequate to meet present needs.

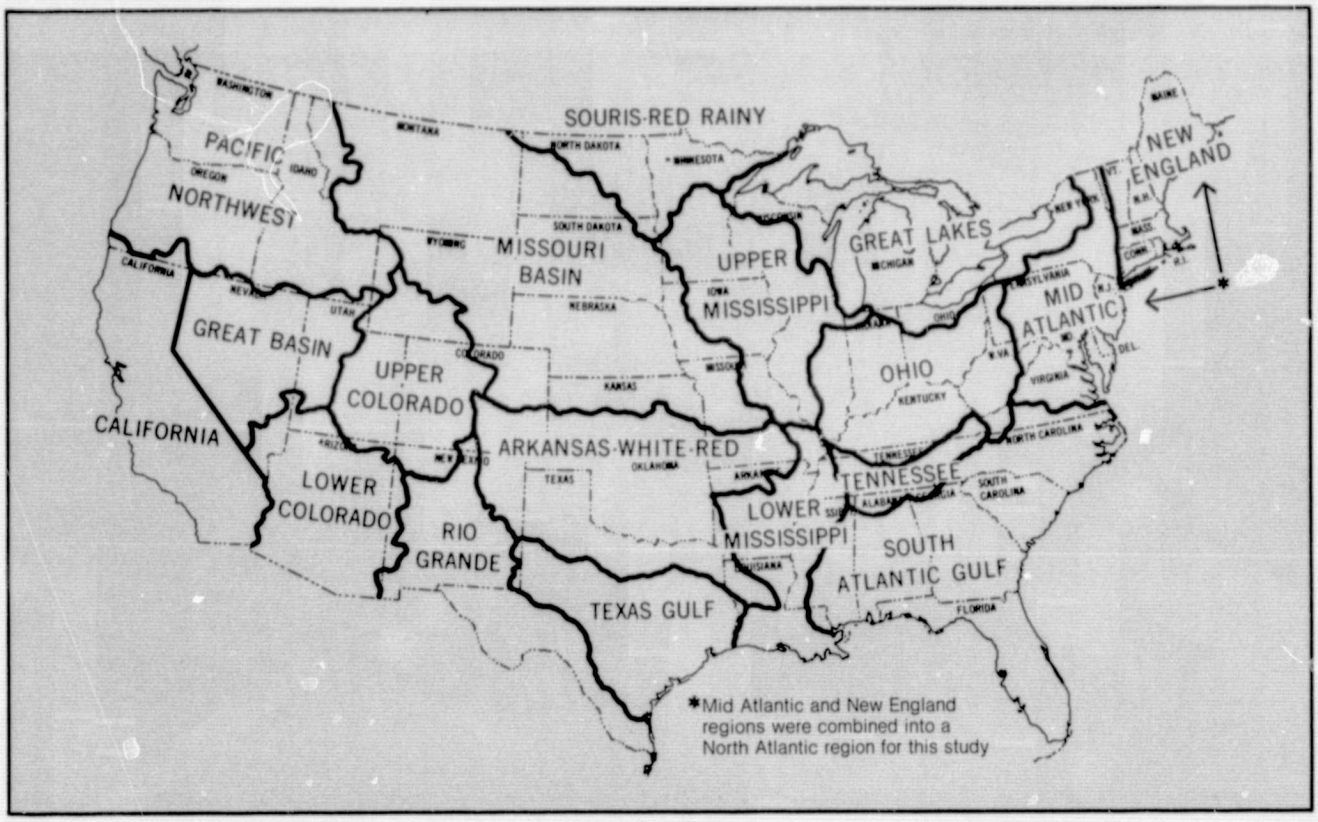
This region has undeveloped pumped storage and conventional hydroelectric sites, and can support additional steam-electric generating plants. The Appalachian areas and the State of Mississippi have commercially exploitable deposits of coal. The area is particularly sensitive to environmental degradation. Thus, any additional development will require much care in planning to avoid undesirable environmental effects.

Great Lakes

Average runoff from the adjoining States is approximately 63 billion gallons a day. Average precipitation over the lakes exceeds the annual runoff by only a small amount. The lake levels vary according to the imbalance between annual inflow and outflow. Water quality in Lakes Superior, Michigan, Huron and Ontario is good, but there are major pollution problems in Lake Erie and local pollution problems near industrial centers on all the lakes.

This area has commercial deposits of coal as well as existing oil refineries and steam-electric power plants. There is already a considerable amount of water used for industrial purposes and a growing competition for the remaining water available due to navigation requirements. Legal problems related to water use in this region involve Canada, the Federal Government and the 8 States bordering the lakes.

Only those regions impacting directly on the continental United States were included in this study.



Ohio

Water for this region's future needs is available if adequately managed. Many small tributaries dry up in summer and low flows in the lower reaches restrict usage in certain areas. Groundwater aquifers are extensive and of satisfactory quality in many cases. Problems are primarily environmental, caused by acid mine drainage and silt.

Potential energy-related demands for water are extensive. Additional nuclear and fossil-fueled generating plants are being planned. Considerable coal mining, oil and gas exploration and drilling are taking place. The Ohio River is also an important part of the inland navigation network, retaining large amounts of water within that system.

Tennessee

Water supplies in this region are considered to be adequate in quantity and quality for most anticipated needs. The Tennessee Valley Authority (TVA) reservoir system is the most complete water control program in the Nation, providing substantial amounts of hydroelectric power within the region. Additional steam-electric generating plants are a possibility. There is some question whether existing water rights laws are adequate to deal with potential requirements and conflicts in this region.

Upper Mississippi

Water supplies are considered adequate until 1980 with groundwater supplies plentiful and relatively untapped. Extreme low flows occur during midsummer. Surface water quality is generally satisfactory, but local problems exist due to agricultural runoff and urban area pollution. The primary problem is controlling high flows and increasing low flows. Extensive development may create sufficient thermal pollution to threaten aquatic ecosystems within the region's rivers.

Lower Mississippi

This region presents unmatched opportunities for water supply, navigation and waste disposal, but requires proper management. Groundwater is available at relatively shallow depths and artesian flows are available from deeper wells. Potential energy related developments in this area include oil refineries, steam-electric and gas plants, and a superport.

Lack of water is not expected to pose any problem; the largest obstacle is lack of adequate laws and/or regulations relating to water use. The latter may create conflicts as competition for the water increases.

Souris—Red—Rainy

The area east of the Red River generally has an adequate water supply of fair to good quality. To the west of the river, quality tends to deteriorate—although several good aquifers have been located containing fair to good quality water. Initial estimates indicate water supplies will be sufficient to meet projected requirements. Future planning must consider, however, the international implications to Canada of any proposed development.

Missouri

Surface water availability varies both seasonally and over time. Droughts are not uncommon. Groundwater availability and quality also vary. This region has potential hydro- and steam-electric generating plant sites. Most important of all are the Fort Union coal beds and associated development proposals, including use of coal-slurry pipelines.

Major problems can be expected from two sources. First, competition for water is expected to be intense. Thus, existing laws may not be able to prevent overappropriation of water rights and thereby inhibit energy development. Second, water supplies frequently are not located in the same

geographical area as coal deposits. Furthermore, existing groundwater supplies may be disturbed by strip mining.

Arkansas—White—Red

Surface runoff in the high plains is limited because of low precipitation, high evaporation and upstream development. Water supplies are augmented by importing from the Upper Colorado region. Water quality is variable, ranging from poor to excellent according to the stream under consideration. The region's importance stems from the large amounts of oil and natural gas present and there are plans to develop additional steam- and hydro-electric generating plants.

There are two overriding problems: one, water supplies are insufficient where most needed; two, pollution is severe. In addition, many of the streams in the region have had their water rights over appropriated.

Texas—Gulf

In the eastern part—an area of heavy rainfall—both ground and surface water quality is good. Rainfall varies considerably in the central portion, causing fluctuations in runoff. Both central and coastal areas have large amounts of groundwater available, however the quality deteriorates along the southwestern part of the coast. Agriculture depends on groundwater mining in the northwest, where depletion of the supply increases farming costs. There are large amounts of oil and natural gas, which may be recovered by secondary and tertiary drilling techniques, and significant quantities of lignite.

Some areas are already affected by dwindling groundwater supplies and there are problems with pollution of both surface and groundwater resulting from oil recovery operations.

Rio Grande

Essentially, the Rio Grande's stream flow is consumed from its headwaters to a point about 80 miles below El Paso, Tex. Below this point, tributary inflow renews the flow. The headwaters throughout this system are of relatively good quality with salinity increasing downstream due to irrigation needs. All of the region's surface waters are under compact and more is needed to sustain present development.

Upper Colorado

The majority of the available surface waters is committed to downstream delivery and trans-mountain transfer, and stream flows fluctuate widely. Quality is very good, decreasing in the lower parts. Groundwater quality varies considerably and is not as good. Water availability is limited by physical conditions, institutional regulations, economic considerations, and environmental and social impacts. Although thermal pollution has been minor, it is expected to increase. This region has large deposits of coal, petroleum, natural gas and oil shale and there are plans to expand steam-electric generation.

The major problem is simply lack of water. The existing water compacts apparently assumed a water supply much greater than is available. It also appears that water rights granted by the States in this region call for appropriation of amounts exceeding available supply.

Lower Colorado

The Colorado River compact entitles this region to 75 million acre-feet from the Upper Colorado region over each 10-year period. There is also some precipitation as well as groundwater to augment supplies. However, water quality is not as good as in other parts of the country. This region produces large amounts of uranium ore, has significant coal deposits and plans are being made for new steam-electric generating plants.

Without additional water imports, groundwater overdraft will continue, progressively deteriorating groundwater quality. Thus, the major problem is increasing the water supply without increasing the groundwater overdraft.

Great Basin

This is the most arid region. Upstream water quality is excellent but deteriorates downstream as salinity increases. Groundwater is generally good, but also tends to become saline in the vicinity of terminal lakes and sinks or thermal springs. Simple lack of water is the limiting factor in this region's development.

Pacific Northwest

There are large quantities of water not always available when needed because of geographical and seasonal distribution. Hydroelectric power production, navigation and other uses require extensive instream use of the water. While this region has some coal reserves, its chief energy related asset is its conventional and pumped-storage hydroelectric potential.

The chief problems will be environmental: controlling thermal effects from new steam-electric generating plants and maintaining instream flows at levels necessary for water quality, recreation and navigation.

California

Water quality is generally superior, except for imports from the Colorado River basin. There are precipitation extremes between the dry summer and wet winter-spring seasons, sharp variations between the dry south and wet north, and also wide variations in precipitation annually. The forecast is for a significant increase in electric power demand. However, much of the water required will come from the ocean.

Alaska

There are abundant water supplies of good quality, large quantities of oil and natural gas, and a significant potential for hydroelectric power generation. Special care must be taken to preserve the unique environment of this region, for which adequate data is lacking in this assessment.

The Project Independence Blueprint will incorporate these regional categorizations into its plan for national self-sufficiency in the production of energy. Even were there never again to be any energy crisis, such an analysis of our country's potential for future development has long been needed. We are long overdue for a rational review of our remaining natural resources, since knowing their quality and quantity can provide realistic guidelines on national growth patterns. The rewards of such an undertaking will go far beyond the mere search for energy self-sufficiency. This rational inventory of our precious natural resources may well mark the beginning of the Nation's transition from a brash and profligate frontier oriented society to a mature, conservation minded and environmentally conscious national community.■

Trial scenarios showing most promise will receive more detailed analysis.

TRIAL ENERGY SCENARIOS OF ESTIMATED WATER WITHDRAWAL AND CONSUMPTION

(Million Acre Feet)

1977

Withdrawal

Name of Region	Non-Energy Demand	Energy Demand	Total Demand	Total Supply	Percent of Supply Utilized
1. North Atlantic	24.6	18.7	43.3	32.86	131.8
2. South Atlantic—Gulf	13.4	12.8	26.2	46.31	56.6
3. Great Lakes	22.8	18.4	41.2	8.49	485.3
4. Ohio	15.4	23.2	38.6	12.62	305.9
5. Tennessee	2.3	6.1	8.4	10.19	82.4
6. Upper Mississippi	5.5	8.8	14.3	13.02	109.8
7. Lower Mississippi	6.5	3.1	9.6	4.88	196.7
8. Souris—Red—Rainy	0.4	0.7	1.1	3.46	31.8
9. Missouri	23.5	3.3	26.8	33.93	79.0
10. Arkansas—White—Red	13.8	1.5	15.3	20.39	75.0
11. Texas Gulf	21.9	3.8	25.7	7.01	366.6
12. Rio Grande	8.6	0.2	9.0	2.85	315.8
13. Upper Colorado*	7.3	0.2	7.5	9.94	75.5
14. Lower Colorado	9.1	0.1	9.2	1.75	525.7
15. Great Basin	7.4	0.0	7.4	2.57	287.9
16. Pacific Northwest	45.6	1.2	46.8	49.39	94.8
17. California	41.0	1.4	42.4	19.69	215.3

Consumption

Name of Region	Non-Energy Demand	Energy Demand	Total Demand	Total Supply	Percent of Supply Utilized
1. North Atlantic	2.7	0.4	3.1	32.86	9.4
2. South Atlantic—Gulf	3.4	0.1	3.5	46.31	7.6
3. Great Lakes	1.8	0.3	2.1	8.49	24.7
4. Ohio	1.4	0.3	1.7	12.62	13.5
5. Tennessee	0.6	0.1	0.7	10.19	6.9
6. Upper Mississippi	1.0	0.4	1.4	13.02	10.8
7. Lower Mississippi	3.0	0.0	3.0	4.88	61.5
8. Souris—Red—Rainy	0.2	0.1	0.3	3.46	8.7
9. Missouri	14.1	0.5	14.6	33.93	43.0
10. Arkansas—White—Red	8.8	0.1	8.9	20.39	43.6
11. Texas Gulf	9.9	0.2	10.1	7.01	144.1
12. Rio Grande	5.2	0.1	5.3	2.85	186.0
13. Upper Colorado*	4.1	0.2	4.3	9.94	43.3
14. Lower Colorado	4.4	0.0	4.4	1.75	251.4
15. Great Basin	3.4	0.0	3.4	2.57	132.3
16. Pacific Northwest	16.7	0.0	16.7	49.39	33.8
17. California	30.6	0.1	30.7	19.69	155.9

1985

Withdrawal

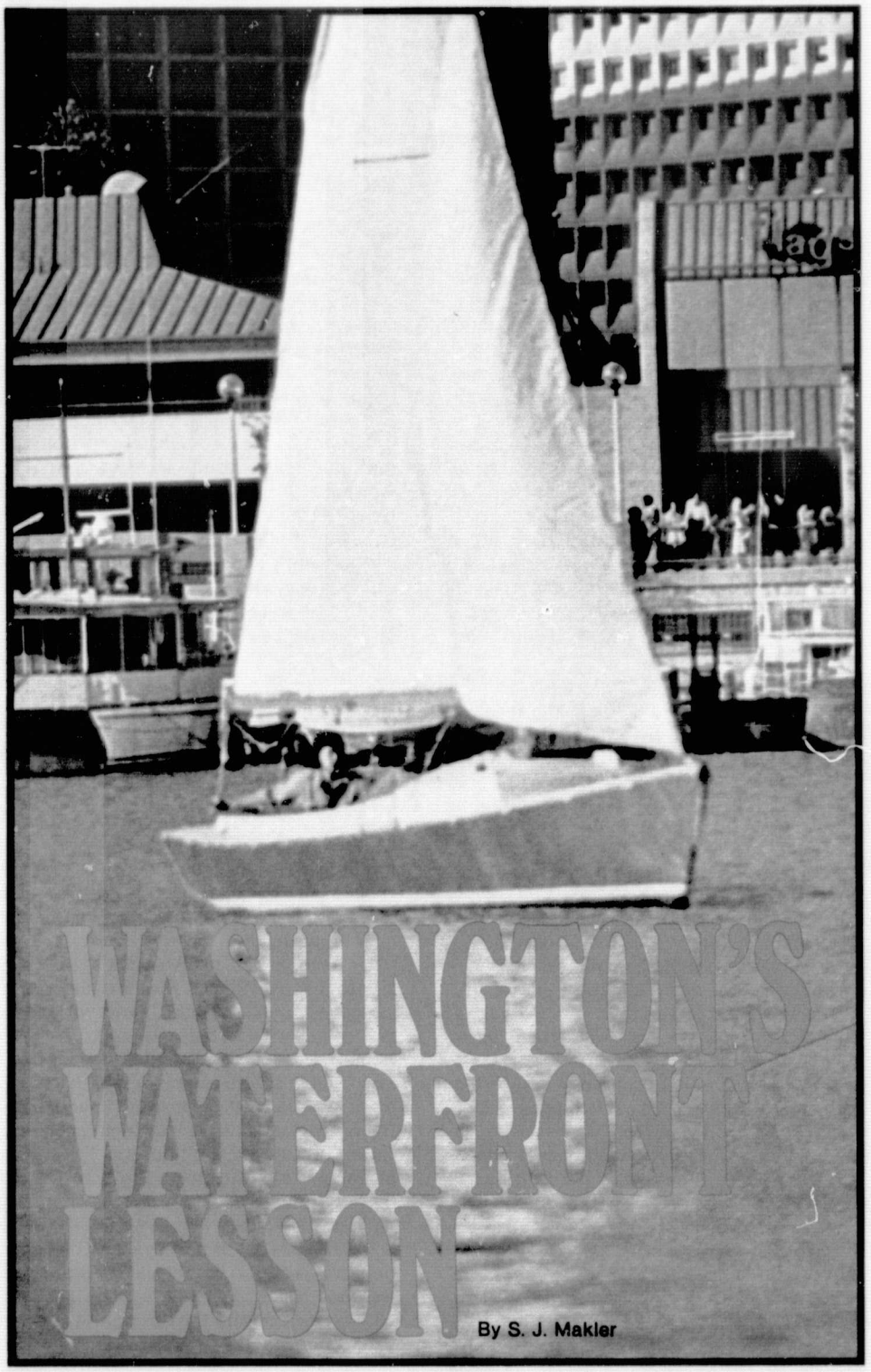
Name of Region	Non-Energy Demand	Energy Demand	Total Demand	Total Supply	Percent of Supply Utilized
1. North Atlantic	3.2	1.3	4.5	32.06	13.7
2. South Atlantic—Gulf	3.9	1.8	5.7	46.31	12.3
3. Great Lakes	2.3	1.3	4.6	8.49	54.2
4. Ohio	1.7	1.0	2.7	12.62	21.4
5. Tennessee	0.6	0.2	0.8	10.19	7.9
6. Upper Mississippi	1.2	1.6	2.8	13.02	21.5
7. Lower Mississippi	4.0	0.3	4.3	4.88	88.1
8. Souris—Red—Rainy	0.3	0.5	0.8	3.46	23.1
9. Missouri	19.4	2.1	21.5	33.93	63.4
10. Arkansas—White—Red	9.9	0.4	10.3	20.39	50.5
11. Texas Gulf	10.7	0.3	11.0	7.01	156.9
12. Rio Grande	5.3	1.0	6.3	2.85	221.1
13. Upper Colorado*	4.6	0.8	5.4	9.94	54.3
14. Lower Colorado	4.6	0.0	4.6	1.75	262.9
15. Great Basin	3.7	0.2	3.9	2.57	151.8
16. Pacific Northwest	19.9	0.2	20.1	49.39	40.7
17. California	33.2	0.1	33.3	19.69	169.1

Consumption

Name of Region	Non-Energy Demand	Energy Demand	Total Demand	Total Supply	Percent of Supply Utilized
1. North Atlantic	27.8	22.0	49.8	32.86	151.6
2. South Atlantic—Gulf	16.3	15.8	32.1	46.31	69.3
3. Great Lakes	30.0	20.6	50.6	8.49	596.0
4. Ohio	17.8	25.0	42.8	12.62	339.1
5. Tennessee	2.7	6.6	8.9	10.19	87.3
6. Upper Mississippi	7.1	11.5	18.6	13.02	142.9
7. Lower Mississippi	7.8	4.0	11.8	4.88	241.8
8. Souris—Red—Rainy	0.6	1.3	1.9	3.46	54.9
9. Missouri	25.2	5.2	30.4	33.93	89.6
10. Arkansas—White—Red	15.8	2.7	18.5	20.39	90.7
11. Texas Gulf	25.4	4.5	29.9	7.01	426.5
12. Rio Grande	9.5	1.3	10.8	2.85	378.9
13. Upper Colorado*	8.1	0.8	8.9	9.94	89.5
14. Lower Colorado	9.4	0.1	9.5	1.75	542.9
15. Great Basin	8.0	0.2	8.2	2.57	319.1
16. Pacific Northwest	62.9	1.6	64.5	49.39	130.6
17. California	43.9	2.2	46.1	19.69	234.1

Source: FEA and WRC demand estimates.

*Water supply data does not exclude water committed by compact to other regions.



WASHINGTON'S WATERFRONT LESSON

By S. J. Makler

A recent survey lists nearly 100 towns and cities engaged in some form of urban waterfront renewal. And many of these same communities find the path to fruition replete with pitfalls—the greatest of plans tossed aside in favor of lesser compromises.

This account of the Washington waterfront presents the author's impression of one renewal project, pointing up the need to prune the blight with caution before resorting to plowing under and reseeding. By so doing we may succeed in retaining what is good among the old while adding the new—we might end up with the best of both worlds.

The opposing banks of the Washington Channel, which lie a mile southwest of the National Capitol, have two distinct personalities. East Potomac Park, a wooded peninsula below the Tidal Basin, is an informal, friendly area. In warm weather it is usually crowded with tennis players, golfers, bicyclists, fishermen, visitors to the Thomas Jefferson Memorial and hundreds of people picnicking on the grassy banks along the shoreline.

Across the half-mile wide channel stands the austere, modernistic Southwest waterfront. Behind a long, railed esplanade rises a string of elegant new restaurants, a motel and the new quarters of the prestigious Capital Yacht Club. Unlike the park, the southwest side rarely has much activity at the water's edge. Aside from the restaurant-goers, the face of the waterfront is usually serene and deserted, a sedate waterfront for high- and middle-income residents rather than the mass amusement place for tourists that some had proposed to locate there.

In the planning stages, the waterfront's developers had promised that the area would be a shaded promenade lined with small shops, flower stands, pavilions, a movie theater, exhibits and things to do and to see day and night, year round. Yet, in terms of vitality and popular interest, the waterfront simply does not live up to these expectations. The reason why is a complex story.

Washington is unique in being the Nation's Capital as well as a place to live and work. Therefore, many Federal agencies were involved in the planning of the new waterfront that would not be present in other cities with similar problems. The potential for interagency bickering and conflicts between public and private interests led to formation of an intermediary nonprofit corporation of prominent local citizens. This innovation created a buffer that made compromise possible and was adopted by other communities as an effective tool in expediting the urban planning process.

A related problem was the strength of urban design considerations in the plan that resulted from this process. The deep seated desire to maximize public benefits ran counter to maximizing privately financed development. Specifically, the massive size of the parking structures envisioned would have cost more than the former marginal waterfront businesses could have absorbed. This concentration on scale made the waterfront vulnerable to political pressures during its 20-year evolution, since it was viewed politically as part of a larger, grandiose urban renewal scheme.

The new waterfront structures, built within the past 5 years, represent the final phase of the massive Southwest Washington Renewal Project which began in the mid-1950s. One of the most ambitious urban renewal programs of its time, it encompassed some 550 acres of the city's slum-ridden Southwest residential area. Everything but a church and a school was removed and eventually replaced with high-rise apartments, townhouses, office buildings and 2 shopping malls.

When the project began, the waterfront, a 27-acre strip along the channel, resembled a small fishing village. It was a colorful mixture of marinas, seafood restaurants, fish stalls, raw oyster bars and piers for pleasure craft and excursion boats. Unfortunately, the same broad-scale approach taken toward the slum section was turned on the old waterfront as well—the idea being to sweep away nearly all the old and replace it with modern design and architecture. However, unlike the slums, the waterfront, though shabby in spots, was playing a desirable and unique role in the city's commercial and aesthetic ecology.

Today, vestiges of the old waterfront still remain in a crowded cluster of seafood stalls to the north of the new structures and the excursion line pier to the south. Some of the names are the same, but for the most part the waterfront's character has been transformed to complement the new image of Southwest Washington, once the city's most blighted area and now its most modern.

Yet the basic question that the Southwest waterfront project raises 20 years after its first hopeful beginnings is the question: Is modernity a desirable end in itself? For many viewers of the new waterfront, the answer is an emphatic no! Its critics have been many and vocal. The *Washington Post*, for example, recently called it: "One of the worst pieces of city planning and the most colossal waste of superb urban scenery in modern history."[1] While an overstatement, the *Post's* criticism nevertheless indicates the disappointment felt by many people who had hoped for more.

The attitude of the authorizers and planners of the waterfront project—the U.S. Congress and the National Capital Planning Commission (NCPC)—reflected a concern which has been growing in the United States for the past 20 years: that urban waterfronts should be treated as an urban resource, not as hopelessly blighted areas to be cut off from the rest of the city. With the crowding and architectural sterility from which so many urban centers suffer, the waterfront has proven to be a potentially valuable commodity when developed wisely as an integral and commercially viable part of city life. Those waterfronts that have deteriorated have done so through gradual cycles of obsolescence and neglect.

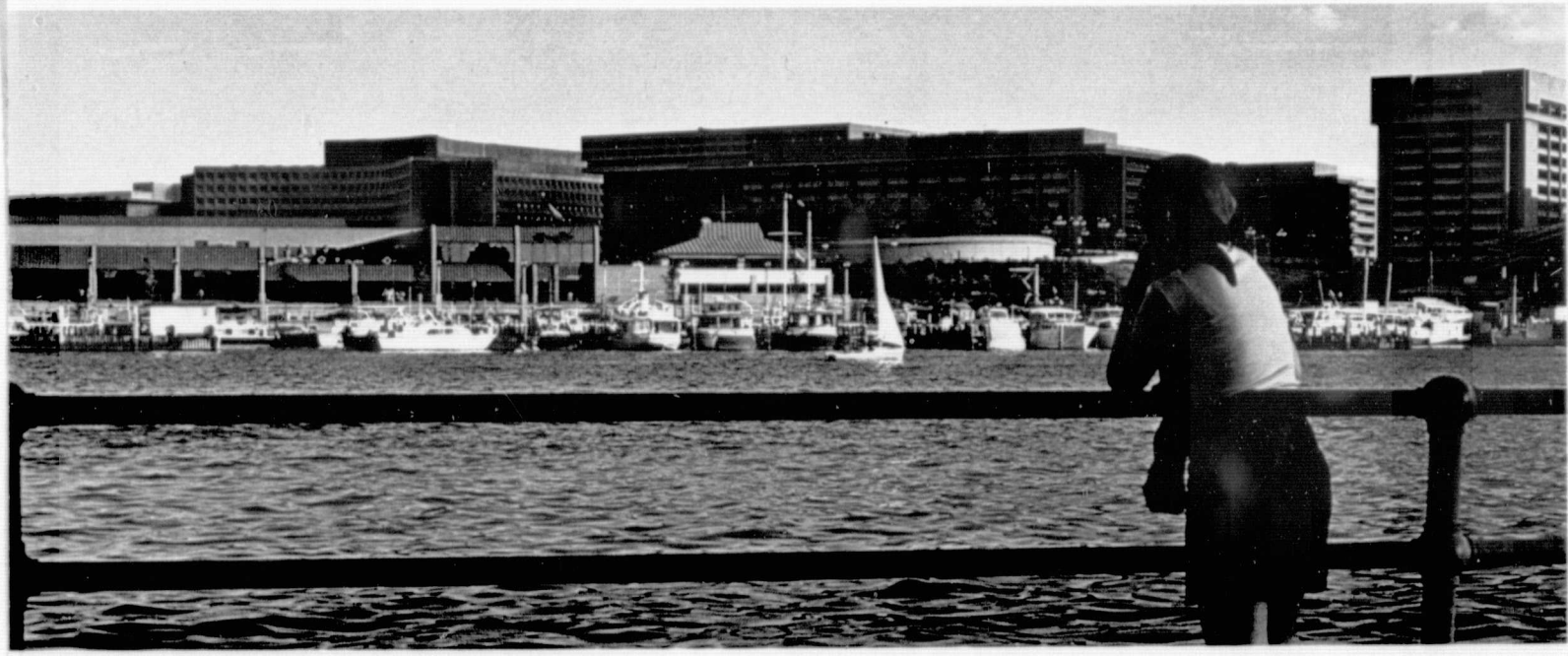
Unfortunately, in America's rush for progress, many cities have overlooked their original reasons for existence—as seaports, lake harbors, or important locations on navigable waterways. Great cities like New York, Philadelphia, Boston, New Orleans and San Francisco-Oakland grew to importance as the exchange points for manufactured goods from overseas to be moved inland and the raw materials from America's interior to be shipped out. Interior cities like Chicago, Detroit, Buffalo and St. Louis originally became prominent as strategic points in inland waterways—either at the confluence of two rivers or as portage areas bypassing dangerous rapids.

But the advent of railways, and more recently heavy trucking, has shifted emphasis on transportation modes and lessened water shipping's once predominant role in the country's trade and transportation system, although it is still vital. Consequently, many urban commercial port areas have suffered a serious decline—both economically, through competition from other modes of transportation, and physically, due to neglect and pollution. As the Wisconsin Department of Resource Development concluded in 1966: "Inability to respond to change is a principal cause of waterfront problems."[2]

Mr. Makler is studying for his Master of Fine Arts degree at the University of North Carolina. He worked as a summer intern in 1974 on the WATER SPECTRUM staff. All photos are his, except as noted.

1 *Washington Post*, Cityscape, August 10, 1974, p. B1.

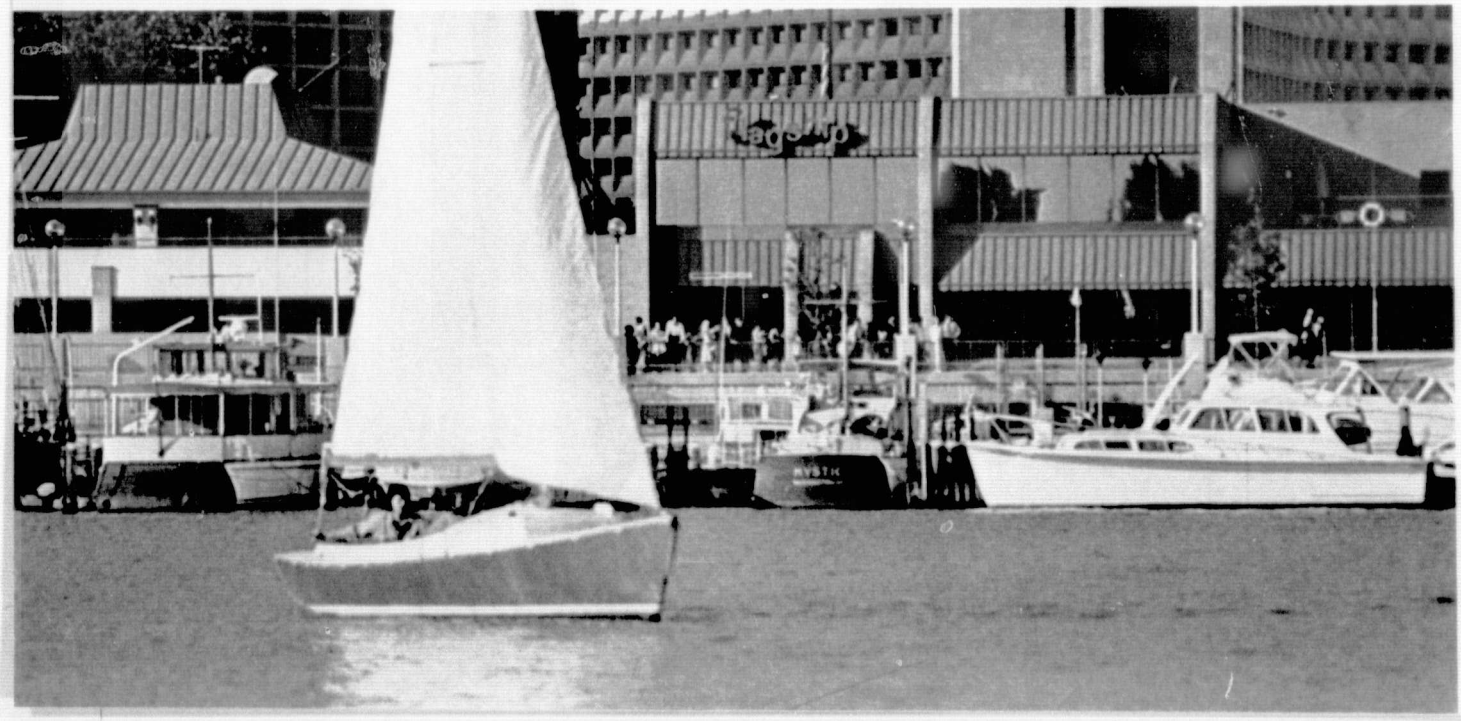
2 *Waterfront Renewal*, State of Wisconsin (Department of Resource Development: Madison, Wis., 1966), p. 6.



The modernistic skyline of the new Southwest rises behind the aging piers of the Capital Yacht Club.

Left—Excursion boats, just south of the new waterfront, await next crowd of visitors to historic Mount Vernon and other downstream points on the Potomac.

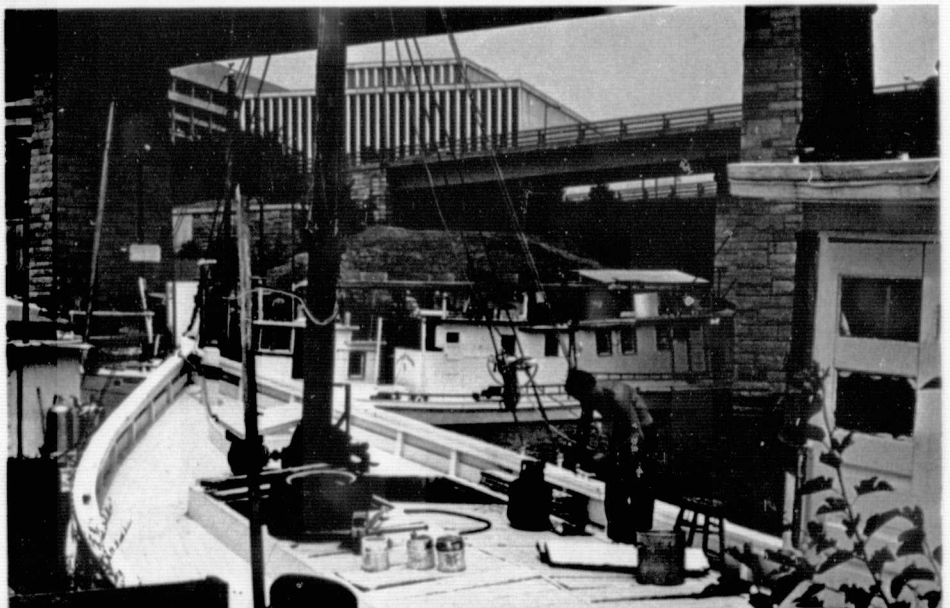
Below—Pleasure boats, both sail and powered, ply the Washington Channel area of the Potomac River.



Several new miniparks scattered among the commercial establishments along the modern waterfront provide nearby residents and sightseers with pleasant views.

Hains Point, the tip of East Potomac Park, is a popular picnic area in warm weather.

A remnant of the old waterfront, this fishing vessel is moored beneath a vista of modern bridges and Federal office buildings.



Washington is an anomaly among major Eastern cities in that it never was a significant commercial port. Government has been its business since the city was founded, and so its waterfront was not burdened with the deteriorating relics of past years so many waterfronts have: decaying warehouses, rotted piers, unsightly cargo handling machinery and so on. Nor was there any objection to the commercial uses to which it has been put over the years—restaurants, marine services and the rest. Its problem, as viewed by those who planned the project, was merely that its simple backwater look was not good enough to be a showcase for the new Southwest adjoining it.

It was an understandable attitude. During and after World War II the city underwent rapid expansion coincident with the growth of the military establishment and other Federal Government services. And, as the car and superhighway made us a Nation of tourists, the capital attracted increasing numbers of people from around the country as well as foreign visitors and officials.

Therefore, in the urban renewal conscious 1950s, Congress authorized a Southwest redevelopment plan which, regarding the waterfront, called for low density commercial use of the kinds of businesses that had traditionally been there. The plan called for construction of a new bulkhead, extending farther into the channel, and also required that Maine Avenue, which ran close to the water's edge, be moved inland so that traffic wouldn't separate the new structures from the channel.

But as far as the eventual commercial development of the waterfront was concerned, Congress injected, in 1958, the single most influential factor to be reckoned with. Endemic to any urban renewal project is the problem of what to do with the displaced residents and businesses of the area to be cleared and rebuilt. In this case, Congress passed legislation stipulating that the existing waterfront businesses be given priority rights for new locations once the public improvements were completed. The intent was to protect the interests of the small businessmen who had made their living on the waterfront for decades. In 1960, additional legislation was passed requiring the Redevelopment Land Agency (RLA), which has the function of interpreting and executing the NCPC's plans, to include the priority holders in whatever renewal plans it adopted.

While protecting the commercial enterprises, many of them very small, this legislation nevertheless had a severely complicating effect on the RLA's work—an effect not envisioned by the Congress. As Arthur Cotton Moore Associates of Washington, D.C. asserted in their 1971 study of the project: "The unique problem of having to conform to a specific Act of Congress, which was open to conflicting interpretation, became an almost insurmountable stumbling block that only time and attrition were able to overcome, thereby costing the city years of time and bundles of money in the process."[3]

Sol Finn, the current Southwest area director for the RLA, basically agrees with that assessment. Recently he described the difficulty of attempting to develop a successful commercial area while limited by legislative specifications as to who has priority in leasing locations.

"We didn't have the option of finding one general waterfront developer and letting him develop the area," according to Finn. "The fact that we had to give existing businesses priority added complications in that we had to find a different developer for each little piece."

As the RLA's director of commercial disposition, James Brown sums it up: "There have been a lot of inquiries from interested developers that we've had to reject."

All the publicly owned land on the waterfront is now under lease. The RLA's main goal now, said Brown, is to do what it can to expedite construction by the lessees who haven't yet built. Brown offered, as an example, negotiations that went on last summer between the Capital Yacht Club and the Washington Metropolitan Area Transit Authority (WMATA). WMATA plans to begin construction this winter on a cross-channel subway below 10th Street.

To construct the tunnel WMATA will be forced to tear down the present yacht slips. According to Brown, the transit authority offered to build temporary slips while construction was underway and, ultimately, to build new slips for the club when the tunnel is completed. The complication, however, was that the yacht club, which cherishes its venerable image, would like WMATA to rebuild its permanent slips exactly as they are now by using authentic, aged pilings.

While the bargaining continued, the RLA assisted a developer interested in building floating boat slips at the presently unused and dilapidated Pier 3 site, a quarter mile south of the Capital Yacht Club. By helping speed this construction, the RLA hoped to provide the yacht club members with temporary berthing facilities, aid WMATA in its work on the tunnel, and replace an old pier with attractive new slips.

The process of redeveloping the waterfront, as well as its ultimate look and character, was a matter of considerable debate, controversy and even litigation through the 1960s. (At one point construction of the parking lots and main level decks above them, which began in 1969, was temporarily halted by a lawsuit.)

The most ambitious proposal for the waterfront was offered in 1963 by the Washington architectural firm of Chloethiel Woodard Smith & Associated Architects. Known as the *Ponte Vecchio* plan, it involved developing both sides of the channel—East Potomac Park as well as the Southwest waterfront—and joining them with a shopping bridge across the channel. Models of the design projected a distinctly Venetian flavor—similar to the original *Ponte Vecchio* setting—bristling with marinas, restaurants and shops as well as a proposed National Aquarium at the far end of the bridge. The plan included connecting the waterfront and the park via a minibus system that would also tie the waterfront area to what is now the L'Enfant Plaza mall just to the north of the waterfront.

Although the concept was accepted by the Washington Channel Waterfront, Inc.—set up in 1961 as a blue-ribbon corporation of prominent local residents and members of government to act as a planning consultant for the RLA—the major proposals were lost in unsuccessful attempts to coordinate the efforts of all the government agencies involved. According to the Moore report: "The proposals for the Ponte Vecchio and the Aquarium were generally well received, but became bogged down in bureaucratic haggling over funding and the use of existing developed park lands."[4]

Today, the designer of the *Ponte Vecchio* plan prefers to forget that disappointment and talk about the future. At her offices, a refurbished warehouse beside the historic Chesapeake & Ohio Canal in Georgetown, Mrs. Smith recently explained the extra incentive a waterfront offers an

[3]Moore, Arthur Cotton, *et al, Bright Breathing Edges of City Life*, (Washington, D.C.: Arthur Cotton Moore Associates, 1971), p. 2/12.

[4]Moore, *op. cit.* p. W/14.

architectural designer.

"Water has a special attraction. Walking along by a river or the sea is always exciting to people. Life on a waterfront is always exciting. Unfortunately, plans don't always have that excitement . . . . To me, there must be lots of things for people to see—not just restaurants, but houses, shops. The waterfront should give the feeling of being a community."

James Maltby, vice president of Doxiadis Associates, Inc., an international firm of architects and designers, says the challenge put to an architect is: "How can you recreate a scale a man can feel at home in?"

Maltby feels that this concept has been either overlooked or ignored in the overall design of the Southwest waterfront, as evidenced by its blocklike structures and broad expanses of concrete and brick. From a commercial standpoint, the restaurants there appear to be highly successful. Yet rarely do people linger there. It is unusual to see people strolling along the esplanade, even in the best weather, despite the fact that thousands live in the new apartment and townhouse developments only a few blocks away.

"Americans are just rediscovering their riverfronts," asserts Maltby. "These are just natural people places. And although economics determines what use is to be made of these areas, we have to turn waterfronts back to the people rather than allow private developments which are specifically for one group of people. Access to the water is a right for everyone and it's particularly important in cities, where you usually have limited natural recreational facilities."

Providing pedestrian access to the waterfront from a city's central business district is often one of the most difficult design problems in a waterfront renewal project. The reason is that, traditionally, transit planners and railroads have taken the path of least resistance—that is, through flat waterfront land—for their highways and tracks, effectively cutting off the city from the water in many cases.

"We try to bridge over whatever the road network might be," explains Maltby. "The waterfront has got to be given back to the pedestrian."

In Louisville, Ky., for example, where an elevated freeway and a railroad line run along the water, Doxiadis' designers first proposed bringing the waterfront to the downtown area by digging an inlet under the freeway and creating a small yacht basin that would be surrounded by walkways, shops and office buildings. After that concept was rejected in 1964, the alternative plan took the form of providing access from the downtown area by means of a belvedere (a plaza elevated above the freeway), which also had the advantage of offering an excellent vista of the Ohio River.

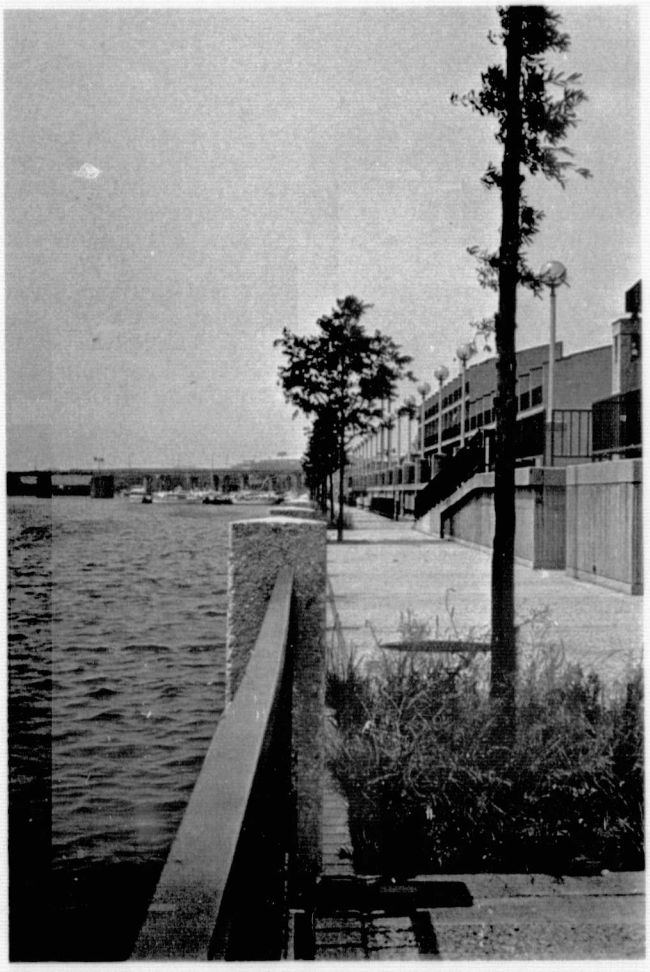
The earliest plan for renewing Southwest Washington contained a similar idea. In 1956 developer William Zeckendorf suggested linking the planned nexus of Federal office buildings to the north with the waterfront through an extension of a proposed *Tenth Street Mall* over a set of existing railroad tracks and the planned Southwest Expressway. This proposal would also offer an extensive view of the Washington Channel and the Potomac River that bracket East Potomac Park.

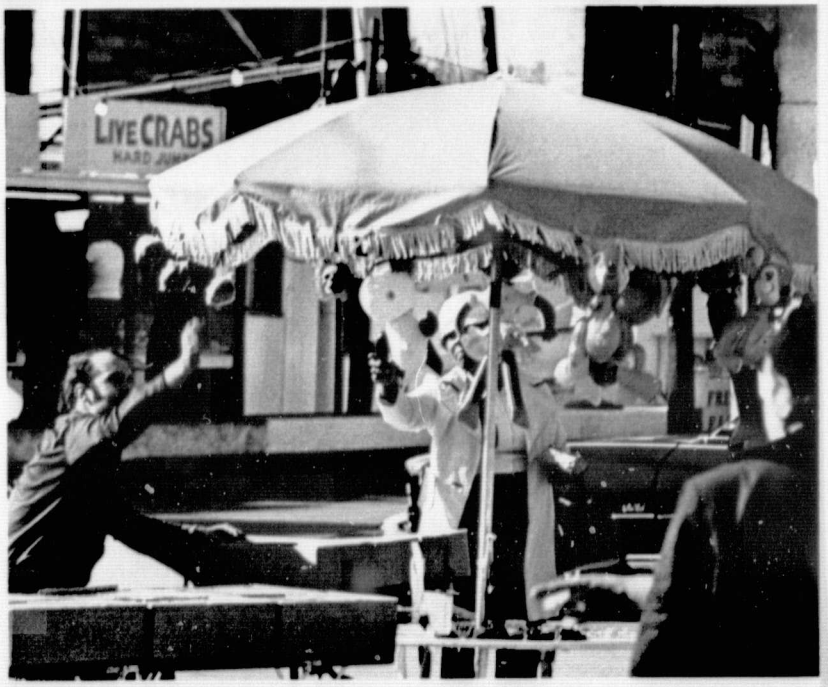
Out of that suggestion has come a circular overlook with a fountain, benches and trees that provides a view of the waterfront at the south end of what has now become L'Enfant Plaza in the place of the Tenth Street Mall proposal. Unfortunately, this overlook part of the plaza is little

Yesterday's waterfront, while not as pretty as today's, still had a color and charm of its own. Photo by Gene Abbott, Washington Star

Shellfish vendor empties a basket of live crabs onto a display counter inside one of the remaining seafood stalls that once extensively populated the old Washington waterfront.

Railed esplanade reaching toward the horizon symbolizes image of the new waterfront.





Streetside vendor adds to the attractions at the waterfront fish market.

Aerial view of Southwest Washington in transition. Houses and small businesses in foreground and most of the marinas were removed from the waterfront to make way for modern high-rise residences and new commercial structures.

Photo by Gene Abbott, Washington Star

frequented today. In addition, descending from the overlook to the waterfront on foot involves walking along a narrow and circuitous sidewalk and crossing several heavily traveled roads.

The primary manner of reaching the waterfront, then, is by car—a situation recognized by incorporating both innovative and controversial semiunderground parking lots beneath the main deck of the new structures. From a design standpoint, this solved a number of problems.

Besides providing the necessary parking area for the remaining businesses, this innovation elevated the new construction above the level of potential flooding without exceeding the zoning height limits demanded by the controlled urban design. Narrow slits a foot higher than the level of the esplanade permit flood waters to enter the semiunderground parking area, thereby sparing the overhead commercial structures.

However, building the flood control and parking decks, which cost some $3 million, proved a complicated affair. Plans originally called for the private developers to build them, which proved economically unfeasible, particularly for the smaller operators. By 1968, therefore, the RLA agreed to revise the plan by building the parking structures with public funds and leasing them to the developers.

The process of renovating the Southwest Washington waterfront began in an atmosphere of high ideals and laudable goals, but also with a generally unclear concept of what should be done. It evolved in an atmosphere of confusion and compromise that served only to restrict alternatives and dilute most of the imaginative ideas that were offered. As a result the area has been given a facelift, but at a considerable cost. The old waterfront was a commercially viable enterprise—as is the new—but it had a color, charm and character that are irrevocably lost.

The low density dictated by the priority given urban design considerations lowered potential revenues. However, the area has been made accessible to the public and tourists, is more organized and new in appearance, and maintains the traditional mix of waterfront uses. Thus, as the Moore study of the waterfront concludes:

"Washington will get an amenity benefit from its waterfront, although at a loss of some of the former, old charming business structures, because of massive clearance—but it will probably only realize a fraction of its sizeable investment through increased tax returns."[5]

Mrs. Smith believes the future of our cities will depend on the "amount of respect we have for where we live." In this sense, then, perhaps the best approach for any urban area to use in a similar situation would be to tend its waterfront selectively, like a garden. As the writer in the *Washington Post* suggested: "You carefully weed out the dead and decaying plants and replace them with new ones that promise to grow well. Rather than tearing everything up, you lovingly prune and weed and seed and nurture and cultivate."[6] ■

[5]Moore, *op. cit.*, p. 1/12.
[6]*Washington Post*, Cityscape, August 10, 1974, p. B3.

WASTEWATER IRRIGATION AND FORESTS

This article constitutes the sixth in a series of discussions on reuse of municipal wastewater and sludge through various applications on land. The following discussion of forest irrigation in the Northwest is related to the larger river basin study program now underway for the Seattle metropolitan area.

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by James E. Alverson

Although land disposal of wastes is an age-old practice, and remains the predominant method of fertilizing soil in other parts of the world, it is only in recent years that the United States has taken a widespread interest in land application of sewage effluents. Passage of the Federal Water Pollution Control Act Amendments of 1972 publicly recognized land application of treated municipal wastewater as a valid alternative to conventional sewage treatment and disposal into public waterways. In 1974, the U.S. Environmental Protection Agency's eligibility requirements for Federal grants to construct waste treatment facilities reinforced interest in land application as a viable alternative. Most land application studies and research, however, have been directed toward treating the wastewater for reuse or utilizing it to grow crops.

One of the problems with this approach in the Puget Sound region is that cropland is scarce in the vicinity of metropolitan centers such as Seattle, but great forests of coniferous trees exist in abundance due to the region's moist climate.

Irrigation Increases Tree Growth

Early research and pilot studies in the Northwest forests have shown that irrigation can greatly increase tree growth, which is limited by the low rainfall during the summer growing season. Therefore, the use of municipal wastewater for forest irrigation holds considerable promise. Although the research is not yet complete, estimated benefits range from $50 to $100 an acre annually. To be more specific, these benefits could range from $2.2 to $4.4 million for the estimated 44,000 acres that would be necessary to absorb all the wastewater from the greater Seattle metropolitan area.

These figures are based on a feasibility investigation of forest irrigation conducted by Stevens, Thompson & Runyan, Inc. (STR) as part of the river basin study program for the Seattle metropolitan area. STR prepared the wastewater management and water quality elements of the program.

Our investigation concentrated on the concept of using a large scale irrigation system to place about 310 million gallons of sewage effluent a day on forest lands within 60 miles of Seattle. Specifically, the study deals with the factors of climate, soils, topography and trees which affect the general design of the system. The broad objective was to come up with an alternative to advanced biological and chemical treatment plants that could also recycle the water and, at the same time, produce an effluent meeting Federal *zero pollutant discharge* requirements.

Although initial results indicate that application of water and nutrients increases forest productivity, a system using wastewater from the Seattle area would be a very costly undertaking according to this study—because Seattle is too low in elevation and too far from possible application sites. If effluent quality is the only benefit considered, such a system could not be justified on the basis of capital and operating costs in comparison with other advanced treatment plant systems. However, the concept holds exciting possibilities for more advantageously located municipalities.

Mr. Alverson is technical manager, Resource Planning Division, with the Seattle office of Stevens, Thompson & Runyan, Inc., an engineering and planning firm.

Dense Forests Cover Region

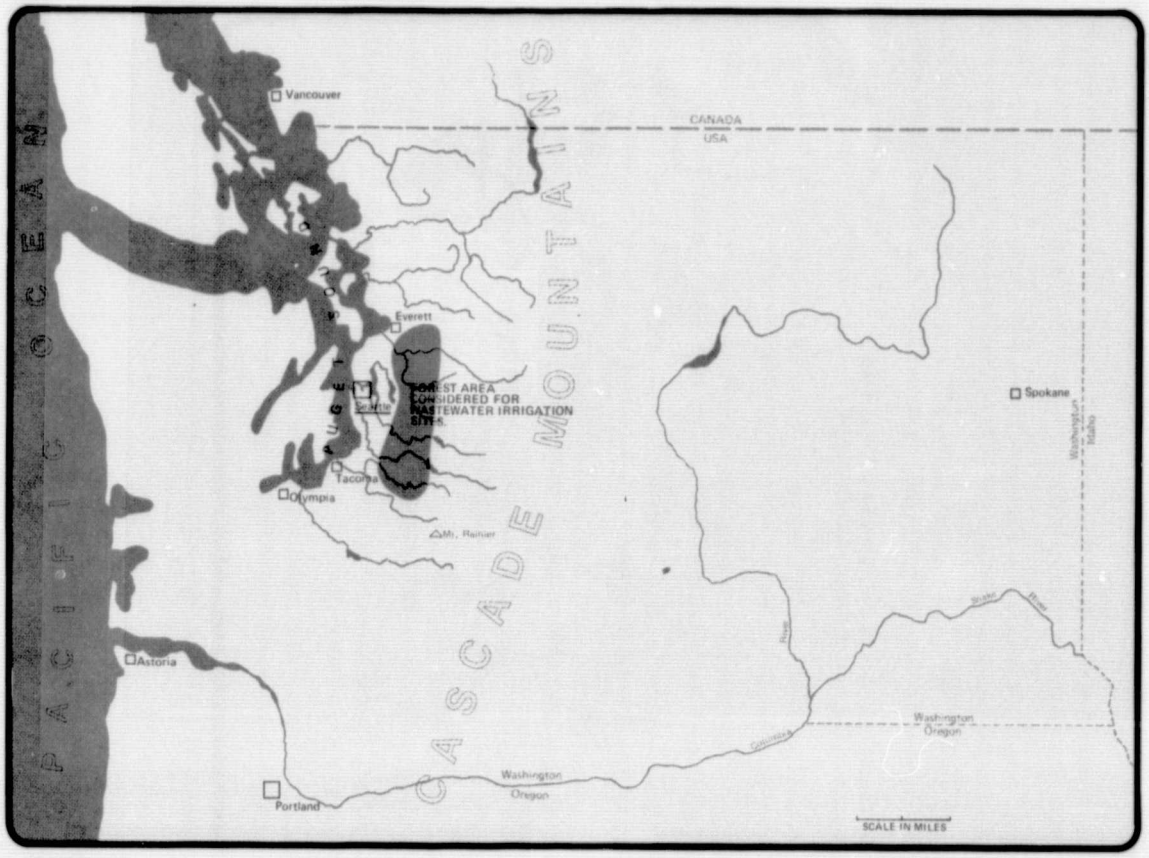
Figure 1 shows the Puget Sound region of the Northwest—a region characterized by dense forests, largely of Douglas fir and western hemlock, which cover lowlands and foothill slopes alike. These forests are nourished by annual rainfalls measuring from 35 to more than 100 inches. The northern Cascade Mountains running north-south roughly 50 to 80 miles east of the Puget Sound shoreline form a natural boundary for the region and a distinct climatic barrier. Moisture-laden winds off the Pacific rise to cross the mountains and drop their moisture as rain or snow before moving eastward. The heavy rains and snowfalls feed into numerous swift-flowing rivers and streams which carry the runoff into the sound.

Most of the people in the Puget Sound region live in cities situated at or near tidewater elevation. The largest, Seattle, is in the Green River-Duwamish basin and has a population around 1.23 million, including its suburban areas. The wastewater management system described here also would cover the adjoining Cedar River-Lake Washington basin. Both basins have a total area of about 1160 square miles, including 60 square miles of inland water. Of the remaining 1100 square miles, 700 are covered by forest, about 260 are urbanized and only 83 square miles are classed as cropland. Additional forest lands in the adjacent Snohomish-Snoqualmie basin to the north and the White-Puyallup basin to the south were included in the area investigated for use as suitable wastewater application sites.

All of the sites considered in the investigation are located on the western flank of the Cascade range in a north-south band about 70 miles long, and are limited to elevations between 500 and 2000 feet above sea level, as shown by figure 1. The geology of the region represents post-glacial terrain, since the effects of the most recent glaciation—which occurred 10,000 to 14,000 years ago—remain relatively intact. These effects include numerous lakes, depressions and broad, but deeply incised, valley floors. The uplands are generally covered by compact glacial till which is quite impervious. The glacial outwash deposits found in the low-lying areas adjacent to these till-covered uplands, however, are generally very pervious. Thus, the lack of uniformity in soil characteristics complicates the task of identifying those areas with sufficient soil depth and suitable texture for wastewater application.

Site screening was based primarily on a combination analysis of soils and costs. The first possibility eliminated through this method of screening was transportation by pipeline to more arid areas east of the Cascade Mountains. This would have involved a distance of at least 100 miles and necessitated pumping the wastewater over the mountains. A

Figure 1. Wastewater irrigation sites under consideration in study lie along western flank of Cascade Mountains.



second plan involved transportation by barge to the relatively level forest lands with suitable soils on the western shore of Puget Sound. The cost of handling the large number of barges needed eliminated this alternative. A third possibility was pipeline transportation to primarily agricultural lands located in Lewis County, some 90 to 120 miles southeast of Seattle. The transport distance and sparsity of soils likely to have adequate depth and hydraulic capacity eliminated this option from further study.

Site Selected

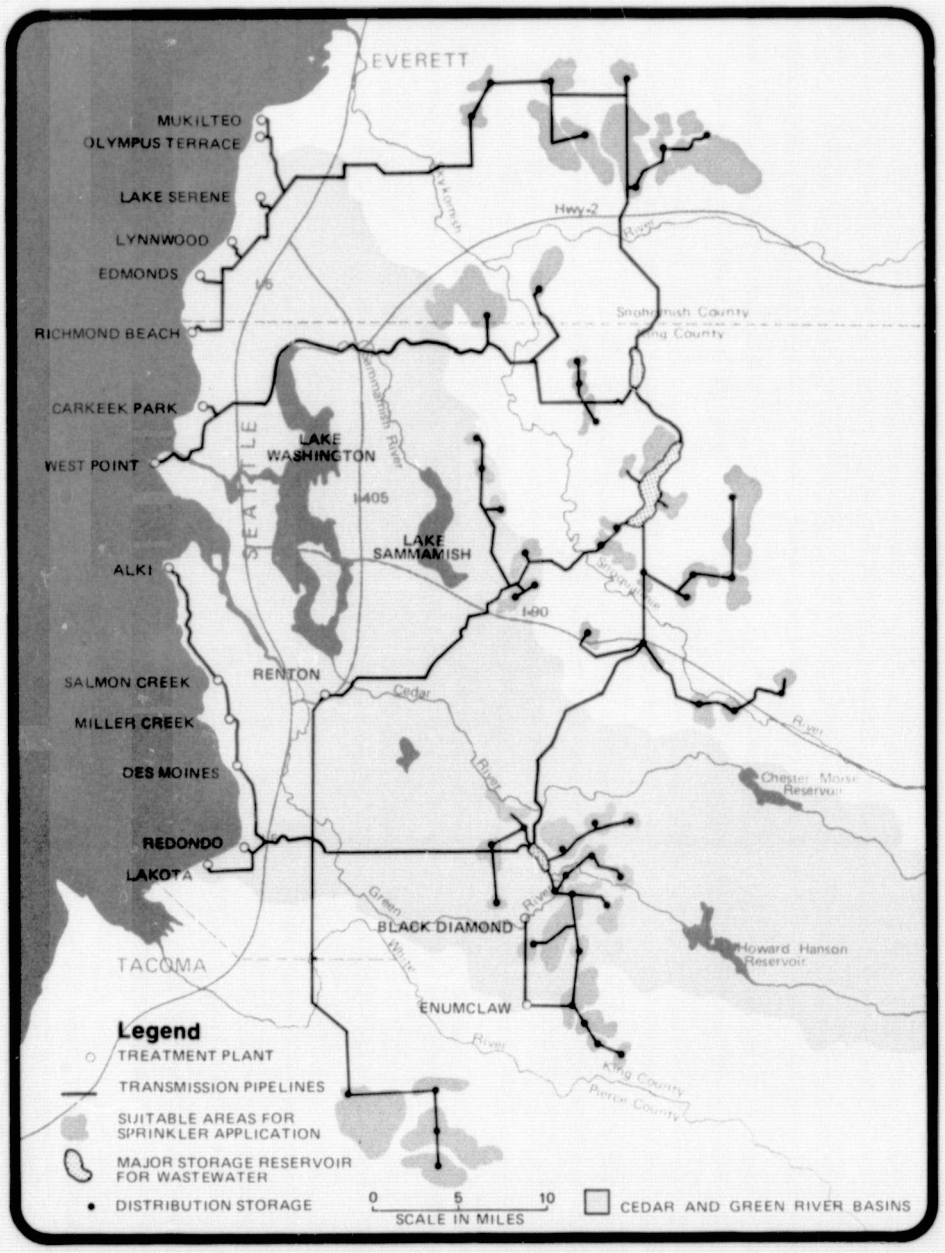
The location which would appear the most feasible is in the eastern Puget Sound region of forested foothill lands generally lying east of the Seattle metropolitan area and below the 2,000-foot contour. For further study of this area, STR established the following criteria and constraints:

- The system must use the entire regional waste flow from all existing municipal treatment plants, because the Federal Water Pollution Control Act (P.L. 92-500) requires consideration of land treatment as a basic alternative for advanced wastewater treatment. Limited funds precluded separate investigations of forest irrigation systems for individual segments of the study area.
- *Conventional secondary treatment, including disinfection, will be provided prior to land application.* This requirement is necessary to minimize health problems and operational difficulties and to achieve high quality effluent from the system.
- Estimated treatment levels to be achieved will be as shown in tables 1 and 2 for various combinations of soils, ground slope and application rates.
- Application will be by sprinkler irrigation rather than overland flow or rapid infiltration, because soils, topography and climate are most favorable for this method.
- Application will be year round, except for fairly short periods of extremely heavy precipitation or snow cover. Winter application rates will not exceed approximately 1 inch per week.
- Agricultural crop lands will not be used due to their generally small size and location of much of their acreage in areas subject to periodic flooding.
- Land ownership will remain with the timber companies, who will contract to take the wastewater, apply it in a generally prescribed manner and provide buffer areas or other types of safeguards to preclude any public nuisance.

Site Characteristics

Because so little confirmed research is available, Dr. Demetrios Spyradakis of the University of Washington's Department of Civil Engineering developed a set of plausible site characteristics which, in conjunction with selected application rates, can be expected to provide a high level of wastewater treatment in the coniferous forest environment of the Pacific Northwest. This information is summarized in tables 1 and 2.

Figure 2. A reconnaissance survey was used to plan irrigation system for Cascade foothills utilizing Seattle wastewater.



Soils in the glaciated foothills that are suited to wastewater application are generally the loamy sands, fine sandy loams and their gravelly counterparts. These soils are classed as medium-coarse to coarse textured and are underlain by impervious glacial till. A minimum assimilative soil depth of 2 feet is judged necessary to achieve the specified degree of treatment, with at least 3 to 5 feet available before reaching an impervious layer. The minimum depth to groundwater should be at least 5 and preferably over 10 feet. Surface slope should be limited to about 25 percent to maintain adequate control of runoff from the site.

Removal of pollutants is expected to be very good for wastewater application rates of 2 to 4 inches per week during the warm drier seasons and 1 inch per week during the rainy winter season. Biochemical oxygen demand (BOD) and suspended solids remaining in the percolating water following treatment are expected to be on the order of only 1 to 1.5 milligrams per liter and total phosphorus about 2 milligrams per liter. The nitrate form of nitrogen is more difficult to remove and may remain in a range from 8 to 18 milligrams per liter as total nitrogen. Approximately 80 percent of the metals are expected to be removed within the 2 foot deep assimilative soil column. Where a deeper soil column is available, greater removal is expected.

Consequently, the quality should meet Federal standards for drinking water, although it appears that nitrogen will be an exception and we cannot be certain about the quantity of lead that would remain. Coliform bacteria and viruses would

Early research shows irrigation can greatly increase tree growth during summer growing season in Pacific Northwest. Irrigation spray tops 50-foot Douglas firs.

Weyerhaeuser Company

be effectively filtered out at the 2- to 3-foot depth without dilution by rain or natural groundwater. The lead concentration should meet Federal standards after the effluent percolates through a few additional feet of soil. The effect of the excess nitrogen that is possible would depend upon the quality and use of the existing ground and surface water. However, reduced wastewater application rates and the dilutional effect of rain and receiving waters could be utilized by site managers to achieve a desired limit of 10 milligrams per liter in sensitive ground and surface waters.

System Requirements

The transportation, storage and application of treated wastewater to suitable sites in the forested Cascade foothills to the east of Seattle would require a major network of pipelines, pumping plants, storage and distribution reservoirs and sprinkler systems. Figure 2 locates the proposed secondary waste treatment plants and pipeline routes together with those forest lands possessing soils suitable for wastewater application. The latter were determined on the basis of a reconnaissance survey.

A net irrigable area of about 82 square miles would be required for an average wastewater flow of 310 million gallons per day. However, a gross irrigable area of 130 square miles has been identified to allow for buffer areas around streams, roads and buildings—and for exclusions of minor areas with unsuitable soils or which are too steep or high to be irrigated. These lands have been delineated solely from soil surveys, which exclude small towns, communities, excessively steep slopes and municipal watersheds. Three surface reservoirs would be provided. Total storage capacity required would be about 168,000 acre-feet in order to provide for the seasonal differences in application rates and fluctuations in the amount of wastewater produced.

An important part of the system operation is a comprehensive monitoring program that would measure all significant effects of the system. Monitoring at the forest sites would include performance characteristics (flow and wastewater quality applied versus flow and effluent quality after land treatment); natural physical conditions (air temperature, soil temperature, rainfall, soil moisture, etc.); environmental impacts (surface water, ground water, soil, vegetation, etc.); and social impacts (community satisfaction, odors, aesthetics, etc.).

Periodic Resting of Sites

The plan provides for periodic resting of each site for 1 of every 6 years to restore its treatment effectiveness. This long-term rest period will allow organic sludge buildup in the aerated soil column to be eliminated by the soil organisms. It will allow concentrations of heavy metals in the top few inches of soil to be leached downward a few feet, carrying such concentrations below the shallow root zone so that understory vegetation, such as salal and huckleberry, can regenerate and thrive. The allowance for long-term resting periods increases the required land area by about 20 percent, but is judged necessary for a permanent system of forest irrigation.

Total annual wastewater application in the coniferous forest environment will be approximately 104 inches, with weekly rates ranging from 4 inches in the summer to 1 inch or less during the winter season of high rainfall and reduced growth. Each site will receive wastewater only 1 to 3 days per week at hourly application rates (0.05 to 0.25 inches per hour) selected to suit specific site needs. Lagoons with storage capacity for one week of application will provide operational flexibility at each site.

Since the mean annual rainfall ranges from 40 to 80 inches, and evapotranspiration losses range from 25 to 30 inches, a large amount of water will remain to percolate to

Monitoring of forest sites includes measuring tree growth by periodic sighting at tree tops through rifle scope mounted on vertically marked pipe. Weyerhaeuser Company

Minute movements of metal band around tree indicate growth in diameter to this inspector. Weyerhaeuser Company

groundwater and eventually into area streams. The infiltration capacity of the soils selected is considered adequate to avoid direct surface runoff. However, the specific impacts of the resulting 110 to 160 total inches of infiltrating water (including rainfall) on underlying ground and adjacent surface waters will require investigation on a site-by-site basis to eliminate those sites where adverse effects might occur.

Additional Research Needed

Initial studies indicate a great potential for the forest irrigation concept. However, little completed research information currently exists that would provide a final assessment of treatment levels and tree growth response to irrigation with wastewater in the Pacific Northwest coniferous forest environment. Specific research is needed to determine whether there is a possibility that some constituents of municipal wastewater can have toxic effects on Douglas fir and western hemlock.

Field studies sponsored by the Corps of Engineers are currently being conducted with chlorinated secondary effluent by the University of Washington's College of Forest Resources at an experimental forest site about 50 miles from Seattle. Research sponsored by Metro of Seattle (the metropolitan area sewerage and wastewater management agency) is also being conducted by the university at the same location to study the application of sludge from Metro primary sewage treatment plants to test plots in the forest. These studies not only measure the ability of typical Northwest forest soils and tree species to purify the wastewater but also their response to the wastewater constituents.

Scheduled for completion in late 1975, the initial results of these studies should provide data necessary to confirm the technical feasibility of using the coniferous forest plant-soil ecosystem common to the Puget Sound region for purification of municipal wastewater. Also, preliminary data should be available detailing forest productivity and life on the wastewater application site following repeated applications. Although the forest irrigation concept offers exciting possibilities for wastewater utilization and benefits to timber production, research must conclusively show no harmful effects to tree growth from wastewater constituents before the system can be endorsed.

Public acceptability has not been assessed, but we believe that the technique would be generally acceptable because of the resource recycling concept inherent in the system. One

Northwest forestry experts inspect experimental tree irrigation project as means of increasing national timber resources. Wastewater could be recycled through similar pipeline system. Weyerhaeuser Company

possible negative aspect relates to a necessary limitation on recreation uses, even though there is believed to be no risk to public health from land application of wastewater under careful management.

Comparing Costs

The alternative to land application of sewage effluent is high technology advanced wastewater treatment. As currently practiced, this process generally consists of tertiary chemical treatment that includes ammonia stripping, effluent filtration and carbon absorption. Besides discharging the effluent into our waterways, this method of treatment has the added ecological disadvantage of requiring huge quantities of chemicals to treat the waste generated in a large metropolitan area. Yet to be assessed are the additional environmental impacts produced by extracting and transporting these chemicals.

However, when comparing the estimated capital and operating costs of such advanced wastewater treatment plants with the proposed land treatment alternative on forest lands for the Seattle area, our reconnaissance investigation estimates the cost of the forest irrigation system to be 2.5 times more in capital expenditure and 1.4 times more for annual operation and maintenance. One of the reasons is that the estimated energy requirements are about 9 times more due to the 20 to 40 miles of transportation involved and a median static lift of 1000 feet needed to reach the elevation of the forest sites with the wastewater.

At the 1973 price level established when the current study began, the estimated capital cost of the transportation, storage and forest irrigation system would be $658 million. The estimated annual operation and maintenance cost for the 310 million gallon a day system would be $17.8 million—of which $11 million would go toward purchase of the energy for pumping, calculated at 1 cent per kilowatt hour. This would include an allowance for all routine operational costs,

TABLE 1

Effluent Quality Expected

PARAMETER	Applied Secondary Effluent (mg/l)	Land Treated Effluent (mg/l)
BOD[a]	25	1.3
COD[b]	70	14.0
Suspended Solids	25	1.3
Total Phosphorus	10	2.0
Total Nitrogen	20	High of 18 in winter to low of 8 in summer
Bacteria and Virus	Greater than 95% removal from chlorinated secondary effluent.	
Heavy Metals	Greater than 80% removal from secondary effluent.	

[a]Biochemical Oxygen Demand
[b]Chemical Oxygen Demand

Note: Land treated effluent quality applied at 2 to 5 feet soil depth. Better quality would be expected at increased depths except for nitrogen, which is mostly in soluble nitrate form.

TABLE 2

Wastewater Application Rates Required[a]

Slope of Ground Surface (percent)	Assimilative Depth (minimum feet)	Maximum Weekly Application[b] (inches)		
		Summer	Fall & Spring	Winter
Up to 8	4	4	3	1
	3	3	2	1
	2	2	1	1
8 to 15	4	4	3	1
	3	3	2	1
	2	2	1	1
15 to 25	3	3	2	0.5
	2	2	1	0.5

[a] Applicable to coniferous forest sites with following characteristics:

1. 15-year minimum tree age
2. below 2,000-foot elevation
3. medium coarse to coarse textured soils (loamy sands, sandy and fine sandy loams and gravelly counterparts)
4. impervious layers below 5-foot depth
5. groundwater below 10-foot depth

[b] Limited to 105 inches per year and hourly rates ranging from 0.05 to 0.25 inches.

Wastewater transported to this Lewis County tree farm could be substituted for pond water spray.

This forested mountain vista looking toward Cascade foothills represents potential irrigation area using municipal wastewater.

facilities maintenance and monitoring, but would not include an allowance for acquisition of the timber lands to be irrigated. The latter allowance would not be necessary, based on the assumption that current timber owners would continue ownership and production.

Long Range Benefits

Based only on the estimates of capital expenditures and operating costs, forest irrigation appears to be impractical for the Seattle metropolitan area. However, in terms of resource use, the forest irrigation system would recycle and use both water and nutrients that otherwise would be wasted into the sea, while the advanced treatment plants would require large quantities of chemicals to be extracted from remote sources and transported to the treatment facility. Research by Woodman has shown irrigation itself to be highly beneficial, producing up to double the nonirrigated tree growth when used in conjunction with thinning and fertilization.* This fact could have significant implications when considering the increasing demands on our finite national timber resources.

Certainly the concept of recycling wastes and wastewater by returning them to the soil as nutrients and moisture for plant growth is in harmony with the growing viewpoint that natural systems must be maintained in reasonable balance. Unfortunately, land application of sewage in the United States has acquired names such as *land disposal* and *land treatment*, both of which reflect the traditional concept that municipal wastes are materials to be treated and disposed of—rather than resources with a potential value if properly managed. Changing to a resource-oriented concept requires a fundamental shift in our thinking.

Ultimately, the final evaluation of a forest irrigation system such as the one being described here will be affected as much by our public attitudes as by its own economics. Perhaps for some community located closer to a feasible site than Seattle there will be an advantage in increasing forest productivity through recycling these valuable nutrients. If this increased productivity is added to the cost of an alternative waste treatment system (advanced or tertiary), the total benefits may exceed the total costs of developing a forest irrigation system. The answer can only come through continued engineering, planning and research in this area of the larger study still underway. ■

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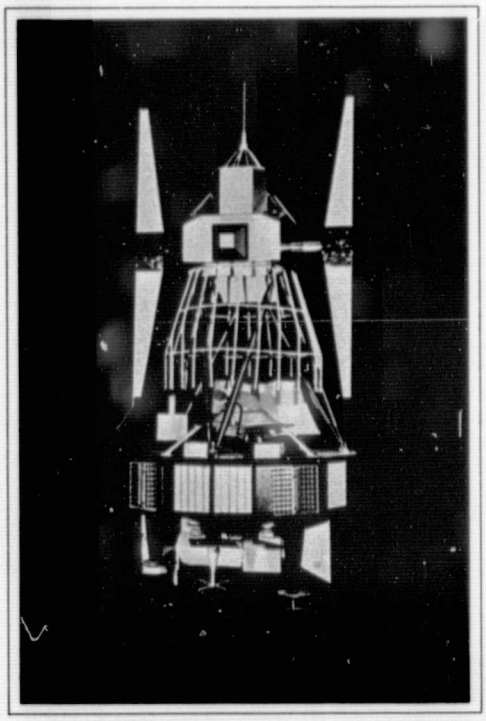

DATA COLLECTION BY SATELLITE

by Lt. Michael J. Toohey and Joseph L. Horowitz

Three days of heavy rainfall in late June 1973 caused a major flood in the mountainous areas of New England. Rain swollen Vermont rivers drained into the upper part of the Connecticut River, bringing that river to its highest known summer flood level. Besides being a record flood, it was one of the first in which the Corps of Engineers received help from a satellite in coordinating its emergency flood-fighting activities.

NASA's experimental polar-orbiting Earth Resources Technology Satellite (ERTS) reported river level data to the Corps' New England Division headquarters in Waltham, Massachusetts, with practically no time delay. The data transmitted helped indicate where the most severe flooding was taking place, aiding that headquarters in directing field personnel to the critical flood areas in Vermont and New Hampshire. Although the rainfall and high waters extended northeastward into Maine, the ERTS relayed data showed the flooding there to be less serious. Prior to ERTS, no such timely evaluation of flooding in Maine was possible, since the conventional ground-based radio relay system does not extend into remote areas of that State.

The ERTS data originated from gages at key river locations. Each gage sensed the stage of the river it was measuring and relayed this numeric information to the satellite orbiting about 500 miles above the earth's surface. ERTS in turn relayed the readings to a NASA-operated ground receiving station at Greenbelt, Maryland, which teletyped the data into the New England Division within 45 minutes of initial measurement. With this information the division headquarters was able to assess the flood situation more rapidly.

In addition to the New England Division's activities, Corps field offices at Jacksonville, Florida; Portland, Oregon; and Vicksburg, Mississippi, are participating with NASA and other Federal agencies investigating the capabilities of satellites to improve the collection and relay of hydrologic data. The 4 separate studies seek to help determine the relative usefulness and economic feasibility of

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Downed telephone lines during the Putnam, Connecticut flood of 1955 illustrate how surface communications may be interrupted when the need is most critical.

Typical ERTS data collection station on a river in Maine.

relaying hydrologic data by satellite versus conventional ground-based techniques in the management of watersheds. Examples of the type of hydrologic data related to Corps management decisions are shown in the accompanying table.

Conventional

Hydrologic data are presently collected and/or relayed by one of the following operational methods: ground survey, telephonic communication or ground-based radio relay. As a group these methods possess a varying range of capabilities and limitations. Ground surveys provide precise measurement of parameters; however, the collection and transfer of information via this means is too slow and manpower-consuming for many management activities—especially those involving large or complex watershed systems.

Where lines are available, telephonic data collection enables areal coverage to be expanded at low cost. Use of telephone lines includes both observers and unmanned instruments. Unfortunately, such communication is subject to interruption by natural disasters such as flooding and high winds, at the time the need for hydrologic data is greatest.

Among conventional methods, ground-based radio relay is another method of expanding the Corps' data collection capability. Radio relay systems are not as susceptible to natural disasters as telephone lines. Radio systems utilize sensors integrated into a collection platform which converts the data to radio signals for transmission to a regional control center. Data received almost instantaneously provides the basis for implementing management decisions during periods of critical flooding.

Radio relay systems, however, are subject to certain disadvantages related to distance and type of terrain. Installation and maintenance of equipment servicing remote reaches of rivers in hilly terrain are costly because of the large number of relays and repeaters necessary to transmit the radio signals to the central control facility.

Satellite

Data relay via satellite, in comparison, possesses most of conventional radio relay's advantages without the need for the latter's costly relays and repeaters. An additional benefit stems from the small size of the satellite platforms. Since they can be relocated at low cost, platforms may be added or deleted as necessary, offering a new capability to support special or changing requirements. During the past 2 years the Corps has been studying the use of satellite data collection systems. The 4 studies mentioned earlier involve 2 different satellites: the polar orbiting experimental ERTS, launched in July 1972, and the National Oceanic and Atmospheric Administration's Geostationary[1] Operational Environmental Satellite (GOES), launched in May 1974, but not yet ready for data collection activities. Both utilize data collection platforms to convert the data to radio signals for transmission.

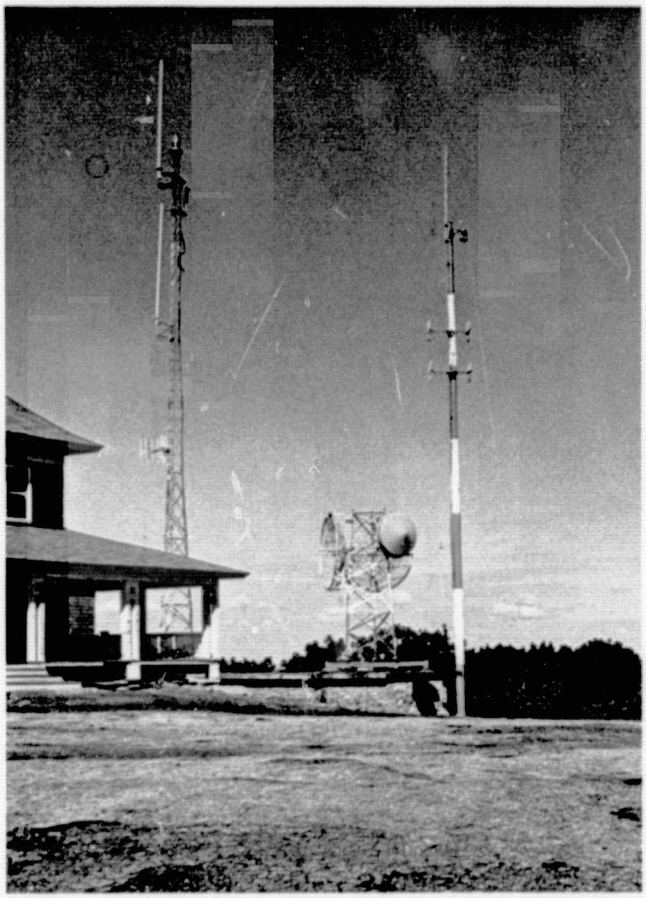
An ERTS data collection platform transmits a signal every 3 minutes; however, the signal is relayed only when the satellite is in view of both the platform and a ground receiving station at the same time. Figure 1 shows the orbital configuration of this satellite. At mid latitude locations the orbital path provides 4 to 6 daily opportunities for the relay of signals. If the system were operational, this frequency could be increased by adding additional satellites. The present ERTS system, which is a test, can only accommodate about 1,000 data collection platforms.

Figure 2 shows the communications range of the GOES satellite, which will be able to accommodate approximately 10,000 platforms. The GOES system will be capable of either interrogating individual stations or obtaining data at prescheduled intervals. The data will be received at Wallops Island, Virginia, and transmitted to a Suitland, Maryland, facility operated by the National Oceanic and Atmospheric Administration, which in turn will teletype the data to the users.

Investigations

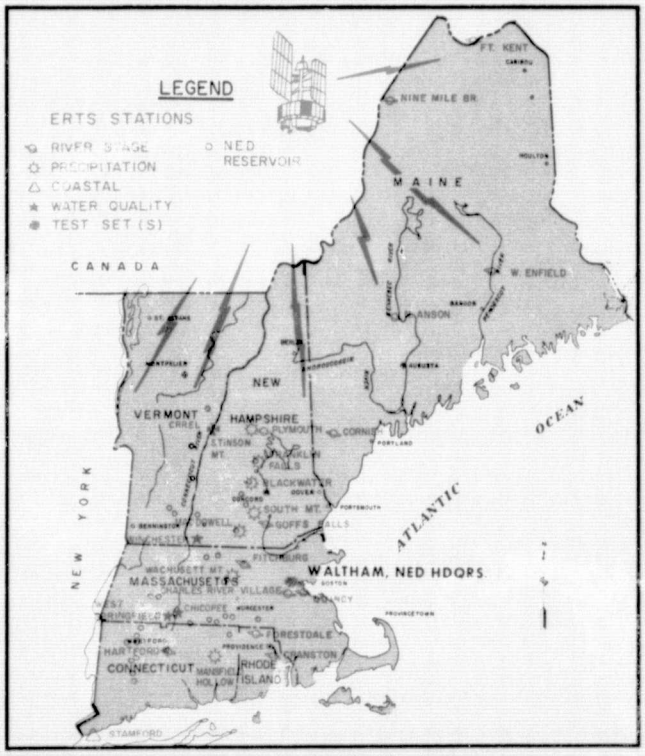
The New England Division of the Corps has been evaluating the utility of the ERTS data collection system for the past 2 years. Twenty-seven platforms have been operating in parallel with the 41 station ground-based Automatic Hydrologic Radio Reporting Network which is the present backbone for flood control reservoir regulation activities at the division. The ERTS data collection platforms have been reliably transmitting such information as river level, precipitation, air temperature and water quality to the division's Reservoir Control Center. The satellite platforms also have been operating successfully in remote areas, demonstrating the suitability for using satellites to economically acquire data previously unattainable from these sites.

[1]Geostationary denotes a satellite orbit that corresponds with the rotation of the earth about its axis, enabling the satellite to remain situated over one location.



Ground-based radio relay network depends on costly relay and repeater facilities in mountainous terrain.

The ERTS data collection platform and its antenna are light enough to move about in response to changing system needs.



ERTS data reporting network for the New England region.

In cooperation with NASA, the New England Division is constructing a ground receiving station at Waltham for direct data acquisition from the satellite. This will remove all ground transmission problems that can occur with teletype relay between NASA and Waltham. The division will test this inexpensive, automated, easy to maintain facility under field office conditions with a minimum number of operating personnel.

The Jacksonville District, in cooperation with the U.S. Geological Survey, has been receiving ERTS relayed hydrologic data for almost 2 years from 9 different locations in central and southern Florida. The information is received at the nearby Geological Survey Office by way of a teletype link with the NASA ground receiving station at Greenbelt, Maryland. Jacksonville personnel have found the data to be reliable and are now utilizing this system operationally.

At the Corps' North Pacific Division, the geosynchronous GOES satellite will be tested in relaying hydrologic data for reservoir management in cooperation with other Federal agencies. Data collection platforms are being installed in Oregon's Willamette River basin to relay data to the division's Portland headquarters. The data will be available approximately 1 hour after GOES acquires and relays the signal to Wallops Island, Virginia. Because GOES is geostationary, the hydrologic data will be available on a regularly scheduled 6-hourly basis or, in an emergency, as often as required.

The Corps is cooperating in an interagency program for development of a satellite ground receiving station at NASA's National Space Technology Laboratories, Bay St. Louis, Mississippi. Participating are NASA, the U.S. Geological Survey and the Corps' Waterways Experiment Station and Lower Mississippi Valley Division. The latter

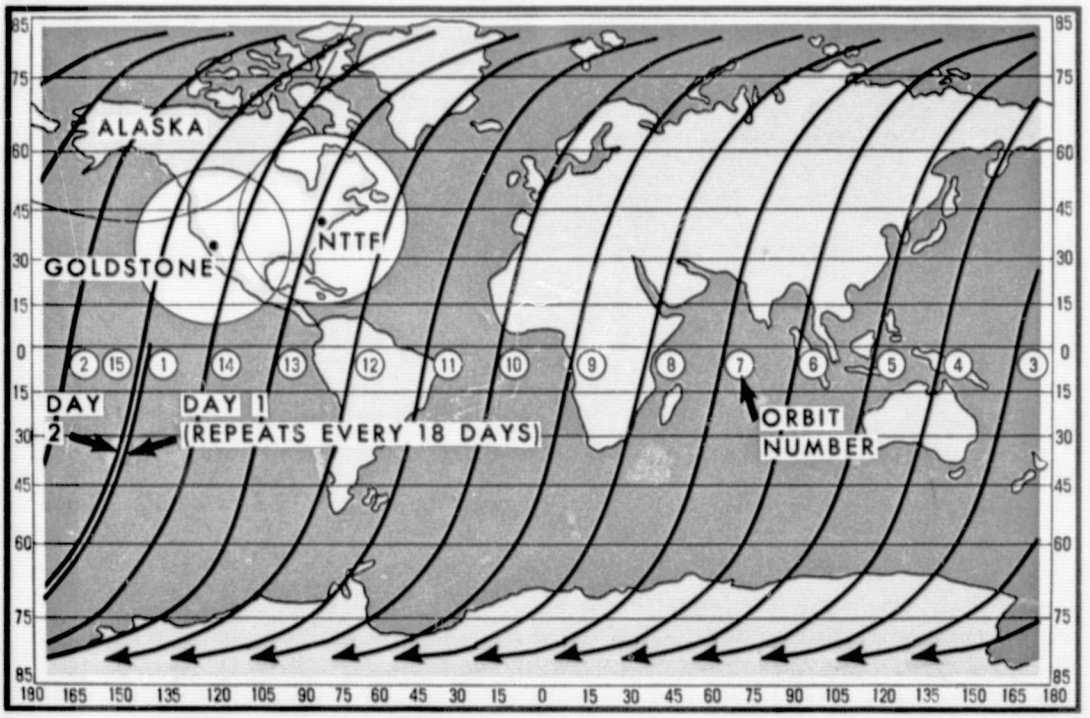


Figure 1. ERTS orbital path follows a new ground trace daily until the 18-day cycle repeats itself.

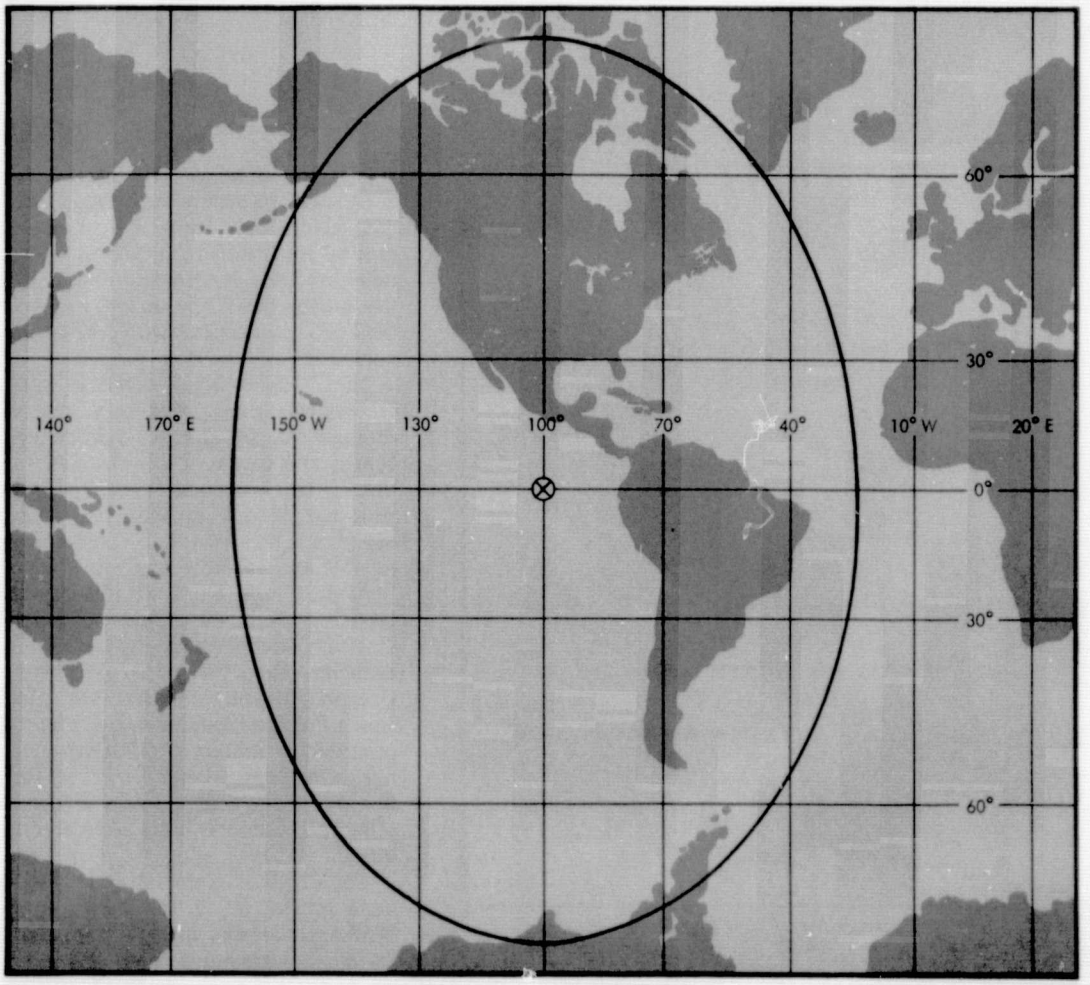


Figure 2. GOES communications range coverage from an overhead station at the equator and 100° west longitude.

Use of Hydrologic Data in Management Decisions	HYDROLOGIC DATA																	
MANAGEMENT CONCERNS	Precipitation	River stage	Reservoir level	pH	Dissolved oxygen	Water temperature	Conductivity	Tide level	Wind speed	Wind direction	Barometric pressure	Soil moisture	Soil temperature	Evaporation rate	Solar radiation	Air temperature	Snow depth	Snow water content
1. Estimate river flow	●	●	●									●	●	●	●	●	●	●
2. Estimate time of travel of river flows of various stages through critical reaches	●	●																
3. Estimate snow melt												●	●	●	●	●	●	●
4. Time reservoir release of stored flood waters	●	●	●															
5. Determine water quality		●		●	●	●	●											
6. Determine tidal and hurricane conditions								●	●	●	●							

Examples of the variety of hydrologic data that concern control center managers.

will place data collection platforms on the Mississippi River to relay hydrologic data to the Space Technology Laboratories via the ERTS or GOES satellites. That data will be retransmitted via ground lines to the division headquarters at Vicksburg, Mississippi, for evaluation and processing. The platforms will be convertible for use with either satellite but will not be able to relay data to both satellites simultaneously.

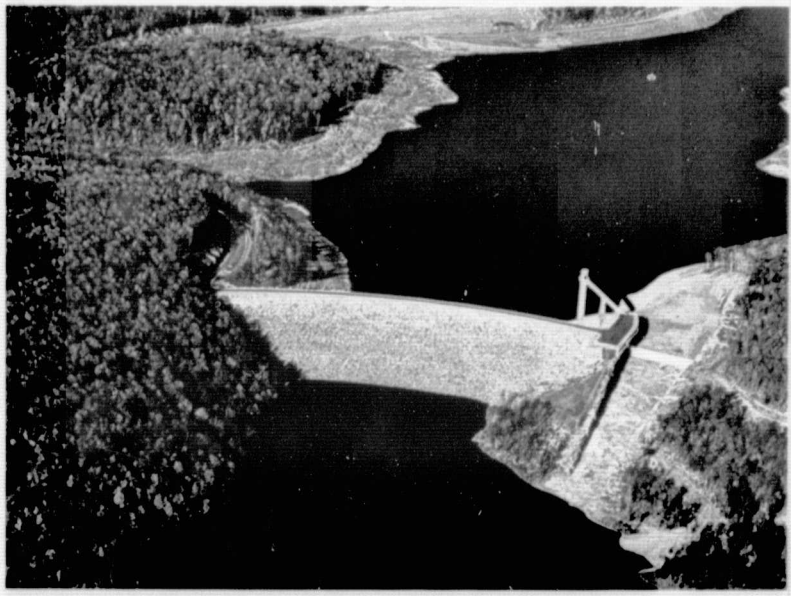
Comparisons

The investigations indicate that costs for data relay by satellite can be less than those for ground-based systems. For example, the New England Division's ground-based Automatic Hydrologic Radio Reporting Network had an initial cost per station in 1969-70 of $20,000. This includes all equipment for the total system (i.e., transmitters, antennas, 4 relays, 12 repeaters and the central control facility with an IBM 1130 computer for data readout and processing). The division estimates the initial cost of an operational orbiting satellite data collection system to be between $5,000 and $10,000 per data collection platform location. This figure is based upon 2 satellites, 10 ground receiving stations and 2,000 platforms nationwide. The cost per platform would be lower if more were installed. Cost estimates are not yet available for a geostationary system.

A questionnaire sent to all Corps offices in July 1973 found that, over the next 5 years, nearly 4,500 data collection locations will be needed Corpswide for the relay of hydrologic information for water management activities.

Conclusion

To date these experiments have demonstrated that data collection by satellite is both reliable and economically feasible. We now know satellite systems can be designed that are undoubtedly more flexible and easily maintained than conventional ground-based data relay. Further studies will establish the relative merits and costs of the orbiting versus the geostationary satellite system tapes.



This flood control reservoir at Colebrook, Connecticut is operated in response to decisions based on data collected by the New England Division system.

Thousands of data collection points presently provide information for the effective management of our water resources. As the complexity of managing these resources increases, expansion of the number of data collection sites will be necessary. Data relay by satellite can add an important new dimension to upgrading the Corps' ability in the field of water resources management. ■

Long standing concern stimulated the preparation that finally brought many well known land and water resource experts to their first national conference on flood plain management.

The First Conference

by Seymour Reitman

Time:
July 25, 1974

Scene:
Congressional Room
Statler Hilton Hotel, Washington, D.C.

Event:
National Conference
on Flood Plain Management

Speaker:
Gilbert F. White, Director
Institute of Behavioral Science
University of Colorado

The speaker begins his summary of the preceding 3-day conference with an anecdote symbolizing one of the many problems his audience had gathered to discuss in the first conference of its kind ever to be held. The anecdote is a recounting of a past conversation between the speaker and a developer that took place in the developer's partially completed apartment building at the edge of a scenic creek running through an urban area.

Standing in an upper story with the developer, the speaker asked if there was any risk in building there. "No," replied the developer. Asked how high the creek rose during the last flood, the developer, pointing to his chest, answered: "Up to here."

Professor White concluded his anecdote by observing that the developer saw no risk, because he would be out of the flood plain in several months after selling his building to someone else. The developer will continue to take this risk until the flood-prone community makes clear that it will no longer tolerate such a practice.

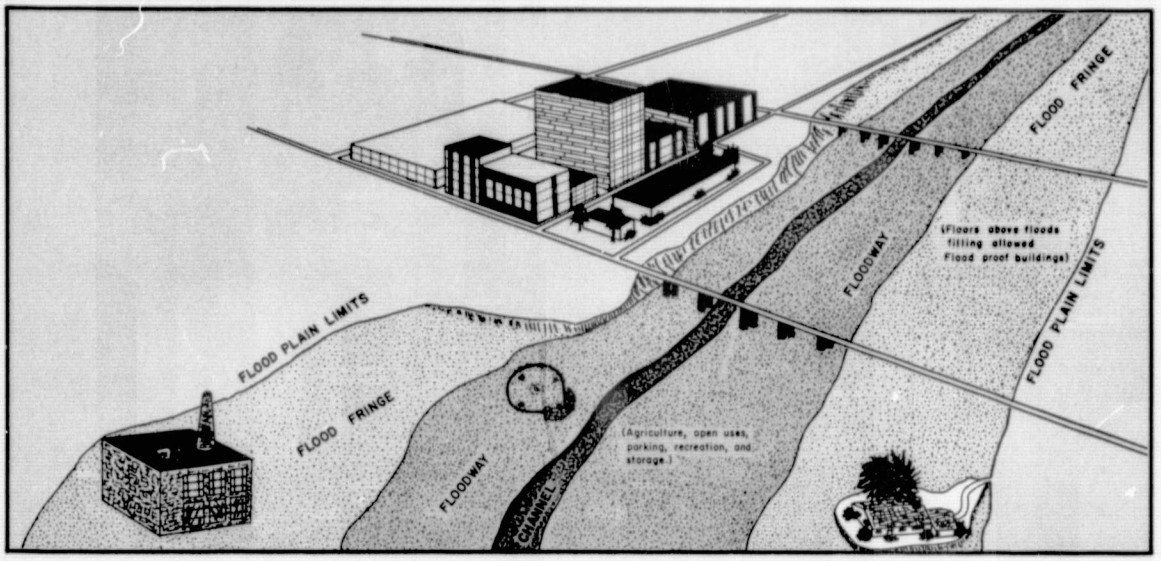
The conference, cosponsored by 8 national associations and represented by consultants from 9 Federal agencies, was designed to exchange ideas and information concerning current flood plain problems among the many Federal, State and local representatives attending.[1] The intent, according to Gordon Zimmerman, one of its organizers, was to review the state-of-the-art, identify actions needed and encourage responses.

A recurrent theme throughout the conference was the value of the Flood Disaster Protection Act of 1973 that amended the preceding, but weaker, Federal Flood Insurance Act of 1968.[2] The 1973 law was praised repeatedly for requiring flood insurance as a precondition for obtaining financing to either acquire or construct buildings in flood hazard areas. This, in turn, means the community must first

[1]Cosponsors were American Forestry Association, American Society of Planning Officials, Council of State Governments, Keep America Beautiful, National Association of Conservation Districts, Soil Conservation Society of America, Sport Fishing Institute and Wildlife Management Institute. Consultants represented the U.S. Water Resources Council, Soil Conservation Service, Forest Service, Department of Housing and Urban Development, Environmental Protection Agency, Geological Survey, Fish and Wildlife Service, Bureau of Outdoor Recreation and Corps of Engineers.

[2]See "A Turning Point," by George K. Bernstein, WATER SPECTRUM, Vol 6, No. 2, 1974.

A flood hazard zone includes both floodway and fringe areas.



become eligible for such insurance by adopting land use control measures.

Other items of Federal interest frequently mentioned during the conference were the Federal Disaster Relief Act, formation of the interagency U.S. Water Resources Council, initiation of flood plain reports and mapping by several Federal agencies and enactment of the recent Water Resources Development Act of 1974—particularly those sections encouraging the use of nonstructural measures for managing the flood plain.

Changes in Federal policy toward flood plains have not yet been reflected strongly at the State and local levels. During his summary, Professor White specifically commented on the lack of action by most of the States, although the deficiencies in flood plain management are becoming increasingly apparent. For example, the concern expressed by all levels of government has not brought forward the type of emergency warning systems that could prevent a recurrence of the Rapid City, S.D. kind of disaster. A related need, he added, is to provide a disaster preparedness program to handle the flood emergency once it occurs.

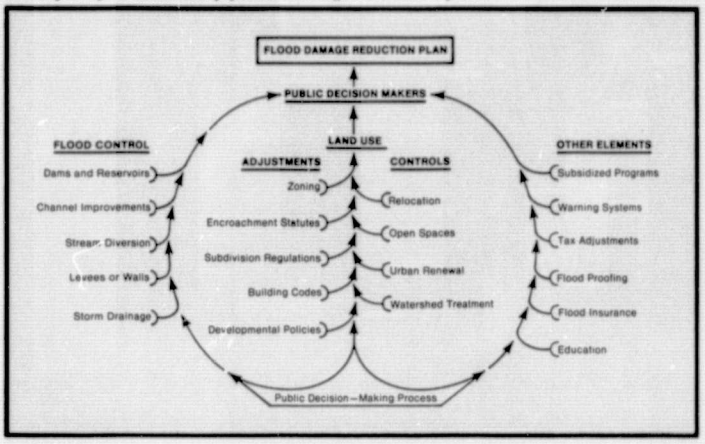
Gilbert White summarizes the conference.

St. Paul is one of Minnesota's flood prone communities which has suffered from numerous floods.

Although few points of consensus were desired or arrived at, there was common agreement that many definitions of importance to flood plain programs were still missing, such as those truly defining the floodway and its fringe area and also a method of delineating a flood hazard area. The most pressing question raised in relation to these definitions pertained to acceptance of the 100-year flood as the standard recurrence interval to use as a guide for flood plain regulations. By accepting the 100-year flood line, White declared, we forego certain economic and social uses of the flood plain and, even more troublesome, we still cannot be sure the benefits are worth that price, or that flood plain resource values are protected. We cannot even be sure that the fringe areas are not still in jeopardy from development.

An even broader issue brought to the conference was the matter of reconciling flood plain management to some form of comprehensive land use planning. Our current uncertainty, as a Nation, in dealing with flood plains stems from lack of a unified concept of what controls are needed, White said. As Texas State Senator A. R. Schwartz commented during one of the panel sessions, the "land use" label can be so disagreeable to some legislative bodies that it may be better to

Example of a community flood damage reduction plan.



Above-Former Waterloo, Ia. official George Griebenow demonstrates huge downtown map with photo insets used to promote public support for flood plain management.

Right-Discussion continued even between sessions.

wave the banner of flood protection as a call to action. The reason is because there is misunderstanding about the relationship between land-use planning and flood plain management.

White also reminded his audience that the gradual groundswell of ideas for flood plain management started back in the 1950s. While recognizing the Nation's right to continue growing at that time, we also began to recognize that the precious character of flood plain land was better suited for agricultural use, open space, conservation, waste recycling and wildlife management.

A flood plain policy at the national level is beginning to be reflected in laws already on the books and, therefore, capable of being translated into actions. Action or inaction, however, depends on local interpretations in most cases, White pointed out. Thus, what is needed is a more positive and integrated view of the ways that Federal agencies can use existing legislation to assist local governments in planning their own programs. Several of the speakers expressed the belief that Congress could support this type of action by issuing a unified and vigorous statement of aim and purpose, White added. Above all, he said, we need a wider interaction with citizens and local groups throughout the country.

White referred specifically to the series of initiatives that could be undertaken at the Federal level to unify national flood plain goals recommended by Laurence R. Jahn, vice president of the Wildlife Management Institute.

Jahn, speaking at the last of the conference's 4 panel sessions, had explained that the absence of a unified national program to both prevent and control flood damages has made it necessary to provide an extraordinary amount of emergency relief by the Federal Government. When homeowners and small businessmen become immediately eligible for long-term, low-interest loans, there is no incentive to relocate out of the flood plain or to floodproof buildings already in the flood plain.

Zimmerman, representing the National Association of Conservation Districts, served as moderator for the initial session, which led off with the general subject: Uses of Flood Plains. The first speaker in this panel was John R. Hadd, representing the Corps of Engineers, who detailed the historical reasons for developing the flood plain in the early years of our country.

In America, Hadd observed, the flood plain was considered the most logical place to locate. Traditionally, the accessibility to waterways and the relatively flat terrain favored flood plains as agricultural, industrial and community sites. The broad, flat lands encouraged road building and the fertile soil made the benefits of cultivating the flood plain greater than losses due to flooding.

Hadd concluded by requesting his audience to bear in mind 4 key points. First, present land use is an expression of past needs. Second, new technology is loosening the bonds that originally tied us to flood plain development. Third, to beware of statistics that falsify what really exists by mixing warranted with unwarranted uses. Fourth, many desirable uses of the flood plain exist that do not endanger property or threaten loss of life.

Speaking next were the current and former directors of the U.S. Water Resources Council, Warren D. Fairchild and Henry P. Caulfield, Jr. Fairchild noted 3 recent developments tending to improve the Federal climate for a more unified action program. These were the 1973 amendments to the National Flood Insurance Act of 1968, the multiple flood plain related studies incorporated into the Water Resources Development Act of 1974 and the adoption by his own council of the "Principles and Standards for Planning Water and Related Land Resources." The latter statement contains the planning objectives and the system of national accounts that form the basis for comparing beneficial and adverse effects of alternative flood plain management plans.[3]

Jahn later praised these new Principles and Standards for inclusion of the environment in planning future developments. Under previous guidelines, Jahn had said, little if any consideration had been given to use of flood plains for ground water recharge and waste recycling. Furthermore, fish, wildlife and recreational opportunities associated with a project had to be converted into dollar values in order to become part of the cost-benefit calculations by which past projects were judged.

Caulfield, the first director of the Water Resources Council, talked about future concerns. Presently a professor of

[3]See "Two Objectives and Four Accounts," by Warren D. Fairchild, WATER SPECTRUM, Vol. 5, No. 4, 1973.

Panel moderator Gordon Zimmerman confers with speakers Paul Caulfield, left, and Warren Fairchild, center, following question period concluding first session.

Corridor display draws attention of conference attendees.

political science at Colorado State University, Caulfield stated that the chief concern is the fact that despite the growth of flood protection structures, flood losses continue to increase. In the past, the interstate character of flood control measures made it impossible to ask the multiple beneficiaries of such projects as dams and levees for reimbursement of construction costs. Thus, local governmental units had no incentive to enact regulatory measures that could have produced nonstructural alternatives. The turnaround in American thinking, Caulfield declared, arrived with the passage of the Federal Flood Insurance Act of 1968, which was the first Federal action taken to charge a premium for the right to occupy any part of the flood plain.

Kenneth R. Wright, a Boulder City, Colo., city councilman and a consulting engineer, contended that despite the current moral support for flood plain regulation across the country, "local administrators and politicians present a dichotomy of thought"—since local governments continue to issue building permits, approve annexations and zone for new construction in the flood plain.

Future success lies with actual land management, not in Federal executive orders and new legislation, Wright argued. When the issue arises in a typical community, 2 polarized groups generally emerge: citizen groups support regulation; realtors, developers, land speculators and industry heads argue that regulations are unconstitutional and unnecessary. As to why the latter group wants to occupy the flood plain, Wright asserted: 1) they won't normally be living on that land and exposing their families to the hazard, 2) the realtor and developer's time frame is a few years, not the 100-year interval and its related 1 percent chance of flooding, and 3) the industry head discounts present worth at 10 to 15 percent interest rates for capital investment, which he believes makes it worth the risk to build. Besides, he can afford to rebuild after flooding—especially if he is federally subsidized.

State Experiences

The conference's second panel consisted of 4 State level officials, each of whom presented a different set of experiences related to attempts to enforce flood plain regulations within his own State.

Representing the Minnesota Department of Natural Resources, James M. Wright stated that regulation was necessary in a State with 350 flood prone communities. While assisting eligible counties and communities to participate in the Federal Flood Insurance Program, Minnesota also has its own State Flood Plain Management Act of 1970 and a recent State building code which communities must adopt. Minnesota also has "good" rural subdivision regulations and a flood proofing code, Wright added. Thus, each permit application in a zoned flood plain area can be subjected to a case by case evaluation.

E. Zell Steever of Connecticut's Department of Environmental Protection pointed out, with the aid of slides, that every part of his State is vulnerable to flooding from 1 of 3 sources: Thunderstorm-induced flash floods, "Northeasters" and hurricanes. Although it has no comprehensive system, Connecticut began flood plain management with a dam inspection program, set encroachment lines for many of its streams and then classified its wetlands according to degree of drainage. Today, Steever said, some measure of preservation and protection is provided by Connecticut's Inland and Tidal Wetlands Laws.

New Jersey's approach, according to Dirk C. Hofman, is more preventive than protective. Representing his State's Department of Environmental Protection, Hofman characterized New Jersey as a staunch "home rule" State in which every inch of land is located within one of its 567 municipalities. Therefore, the legal authority for flood plain management is based on joint local and State control.

Hofman explained that older laws enacted by the State could not always overcome the reluctance of individual municipalities to regulate flood plain development in the face of demands to develop all vacant land in the urbanized areas of the Nation's most densely populated State. The solution was passage of the Flood Plains Act in 1972. This gave the State authority to regulate the floodway, protecting one municipality from possible detrimental actions of another, while leaving the municipality free to regulate the flood fringe area, where the danger is more from inundation alone than from both high water velocities and inundation that endanger the floodway.

Charles Crow, director of the Arkansas Department of Planning, in contrast, described local government in his State as weak. The county judge is the lone authority in most counties. Where incorporated municipalities exist, they are given the zoning power and a planning authority which ex-

tends into extraterritorial areas. Lately, Arkansas has been working to set up a permit arrangement, including a State review process, with the help of the Soil Conservation Service and the Corps of Engineers on the more technical matters.

Unfortunately, Crow admitted, the price of soybeans often dictates land use policy in Arkansas. When marginal forest land is clear cut to convert it to soybean production, the State suffers a long-term flood plain loss for the sake of a short-term agricultural gain.

Avenues to Improvement

The third panel of speakers presented descriptions of successful flood plain management projects. Lloyd Turner, former mayor, discussed the problem of a river-cut city such as Waterloo, Iowa.[4] Originally platted on both banks of the Cedar River, the city's focal point is the river itself. Compounding Waterloo's problem, 5 tributaries join upstream of the city without any intervening terrain capable of storing water for controlled runoff. Since a 100-year flood would inundate 60 percent of the city's assessable property, the cost of relocating the community left only one answer—flood protection devices.

However, using structural devices led to concern for public use of the riverfront areas, not to mention the drabness of floodwalls. Local input contributed a beautification technique incorporating aesthetically pleasing archways built into the floodwalls to protect existing downtown structures while permitting a view of the river during low flow periods.

Turner advocated home rule in order to provide strong citizen backing for local officials, but also offered the information that he had discovered it is not possible to involve citizens at all times. He called for more involvement of field representatives of Federal agencies that are able to assist in funneling helpful grants into the community when the citizens balk at spending so much of the community's tax money for flood protection.

George W. Griebenow, chairman of the Upper Mississippi River Basin Commission, used his experience as former administrator for community development in Waterloo to provide additional enlightenment on using local initiative and public understanding to optimum advantage. Griebenow displayed a large flood map of the type that had been used to help gain public support for measures that would decrease the potential for future flooding in Waterloo.

An example of using Federal funds for a nonstructural project in the flood plain was presented by Charles Kennedy of the Massachusetts State government. Kennedy explained that a "natural valley storage" concept is being applied in the Charles River watershed bordering the Boston metropolitan area. Some 17 natural storage areas would be acquired to retain the wetland regime remaining in the suburban middle third and rural upper third of this partially urban watershed. The sites would be acquired by the Federal Government by either fee or easement.

Interstate level issues in flood plain management were introduced into the conference discussions by representatives of the Northeastern Illinois Planning Commission and Southeastern Wisconsin Regional Planning Commission. J. A. Smedile, chief engineer for the 6-county Northeastern Illinois Planning Commission, which includes Chicago, reported that his commission has made an early start toward recommending approaches to stormwater drainage, recognized as a local responsibility, and overbank flooding problems, considered a State or Federal obligation. In a March 1973 Storm and Flood Water Planning Conference for local officials, Smedile said, the recommendation that ranked highest was that "water must be held as long as possible close to where it falls."[5]

Agnes reinforced public belief in the value of structural flood protection measures for some locations.

Kurt W. Bauer, executive director for the Southeastern Wisconsin Regional Planning Commission, developed the theme that an intrastate or multicounty region is the best level at which to prepare comprehensive development plans for legal adoption. Bauer called the watershed the logical areal unit for water resource planning purposes in an urbanizing region, but only if it could be developed within the broader framework of a regional planning effort relating the watershed to functional (such as transportation) and land use plans. "Once decisions are made concerning land use, the most fundamental water use decisions have also been made," asserted Bauer.

Senator Jennings Randolph, chairman of the Senate Public Works Committee, spoke at the concluding luncheon. He stressed the fact that a changing society makes it mandatory to consider nonstructural alternatives for both the prevention and reduction of flood damage. Senator Randolph briefly cited 3 examples of nonstructural projects provided for in the Water Resources Development Act of 1974.

In the first example, the senator pointed out that Congress had authorized acquisition of 8,500 acres in the Charles River flood plain near Boston to obviate any future need for expensive upstream dams. The second project authorization he mentioned provides for total evacuation, floodproofing and land control measures in the often flooded Mississippi River town of Prairie du Chien, Wis. Senator Randolph's third example was the desire to acquire land and develop recreation facilities on the South Platte River just below the Chatfield Dam in Colorado instead of making extensive channel improvements. The latter alternative, he added, would have been required to handle water releases from the dam had flood plain encroachment been allowed to take place downstream through private developments.

Senator Randolph voiced the congressional attitude toward the prospect of more nonstructural projects by commenting that "the proper and less costly response may well be to let the floods come, but to control the flood area so that personal and property damage will not occur."

There were no specific goals enunciated by the conference, nor were any intended. What the conference did achieve was summed up by Professor White with the statement:

Perhaps the conference has started a new level of energy and vision in our approach to the manner in which we deal with our coastal and inland waterways, and use existing Federal policy to stimulate the State and support local groups in coming up with ways to use these resources for the good of the Nation. ■

[4]See "Urban Renewal Engages a Partner," by Lloyd L. Turner, WATER SPECTRUM, Vol. 1, No. 1, 1969.

[5]See "Consensus: The First Step," by Matthew L. Rockwell, WATER SPECTRUM, Vol. 5, No. 1, 1973.

Events, Deeds & Deliberations

A Partnership Project

Even before the Corps' St. Paul District dedicated its U.S. Highway 75 dam across the Minnesota and Yellow Bank Rivers the district had turned over management of the project to the U.S. Fish and Wildlife Service. Under the terms of an unusual agreement, the Corps and Wildlife Service are sharing a project designed to provide both wildlife and flood control benefits.

Formally dedicated in mid-1974 as the Big Stone Lake-Whetstone River Project, the area being developed straddles the southwestern Minnesota-southeastern South Dakota line. Dedication of the 2½-mile long, earth-filled dam southeast of Odessa, Minn., merely completes the first phase of this joint project. In keeping with the dual goals, the 20-foot high dam contains 2 spillways: one to control the level of the water being impounded, the other for use in an emergency flood control situation.

Although Corps hydrologists will continue to provide guidance on operation of the dam, the project will be managed by the Wildlife Service because of the project's emphasis on formation of a new national wildlife refuge at Big Stone Lake. Not a lake in the strictest sense of the word, the 11,000-acre impoundment envisioned will become a reservoir dotted with small tree-covered islands and backwater areas ideal for harboring migratory birds and indigenous fauna. Wildlife specialists now managing the area predict that the new Big Stone National Wildlife Refuge will develop into a major flyway stopover point in a year or two for many migratory species—including some on the endangered list.

Still under construction are the camp sites that will be blended into the surrounding landscape—so visitors can observe the waterfowl in their natural habitat—a picnic area, access points for canoeing and bank fishing. A perimeter road will incorporate several recreational pulloffs and observation pulloffs will be constructed on County Road 15, which bridges the parallel Minnesota and Yellow Bank Rivers forming the reservoir. This road was raised about 8 feet for a distance of 1½ miles in order to accommodate the rising waters that will average 10 to 12 feet in depth around the reservoir's multiple islands.

Additional flood control building will include a silt barrier and control structure at the outlet of Big Stone Lake, channel improvement below the outlet and bank construction along the lower reaches of the Whetstone River.

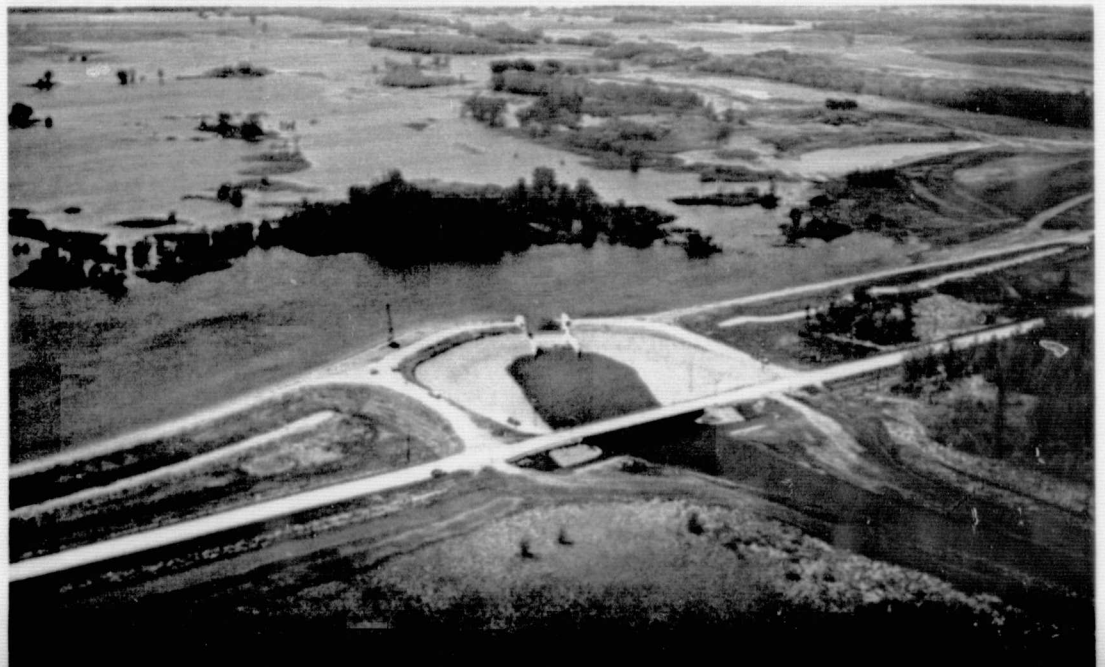
SCOPE Survey

A 38,000-square-nautical-mile area of coastal waters off the Carolinas, Georgia and northern Florida has been surveyed by the National Ocean Survey with the aid of National Oceanic and Atmospheric Administration ships, a hydrographic field party, land support units and an air photo mission.

This team effort, better known as the Southern Coastal Plains Expedition (dubbed SCOPE), covered over 76,000 miles in 2 years of an intensive survey of an area that reached from Cape Hatteras, N.C. to the vicinity of Cape Canaveral, Fla. and as far as 60 miles out to sea. Water depths encountered ranged from the surf zone to about 600 feet.

The type of information collected in coastal waters and the Gulf Stream during the survey concerns bottom

U.S. Highway 75 crosses Big Stone Lake outlet channel below spillway. Area flooding in background is forming new national wildlife refuge.



topography, tidal currents, tide measurements and physical properties of the sea—such as salt content and temperature. Aerial photography complemented the data gathering with coastal photos helping to delineate the location of high and low water lines.

Considerable information is available from the first year's SCOPE operation in the form of survey sheets, aerial photos, shoreline maps, tidal current prediction tables and updated nautical charts. Results of the second year's survey are being processed as quickly as possible to meet the same uses.

Shoreline Erosion Advisory Panel

A 15-man Shoreline Erosion Advisory Panel has been appointed by the Chief of Engineers to assist him in complying with the Section 54 provisions of the Water Resources Development Act of 1974. Section 54 of that act authorizes the Corps to establish a 5-year national program to evaluate and demonstrate low-cost means for controlling shoreline erosion. This section has been designated separately as the Shoreline Erosion Demonstration Act of 1974.

Lt. Gen. W.C. Gribble, Jr., Chief of Engineers, selected his panel from experts in the fields of geography, zoology, economics, engineering and planning. Also considered was the geographical location of each panel member, so that the Great Lakes and the coastal regions of the Gulf of Mexico and both oceans would be represented as equally as possible.

The panel selected its own chairman and vice chairman during its organizational meeting in the Kingman Building at Ft. Belvoir, Va. Joseph M. Caldwell of Arlington, Va., was named chairman and Dr. Billy L. Edge of South Carolina, vice chairman. Mr. Caldwell is a consulting engineer and former chief of the Engineering Division in the Civil Works Directorate of the Office of the Chief of Engineers. Dr. Edge is an associate professor of civil engineering at Clemson University.

Other new panel members named by General Gribble are: Robert C. Baum, Pacific Region representative, National Association of Conservation Districts; Earl William Behrens, associate professor at the Marine Science Institute and Department of Geological Sciences, University of Texas; Ernest F. Brater, professor of civil engineering, University of Michigan; John S. Habel, head of Marine Technology Branch, California Department of Naval and Ocean Development; Joe W. Johnson, professor of hydraulic engineering, University of California; Lee E. Koppelman, executive director, Regional Planning Board, Smithtown, N.Y.; Omar J. Lillevang, consulting engineer for Coastal Engineering, Whittier, Cal.; William D. Marks, chief of Water Development Services Division, Michigan Department of Natural Resources; Evelyn L. Pruitt, coastal geographer of Arlington, Va.; Robert A. Sweeney, director of Great Lakes Laboratory for State University College (Buffalo), Tonawanda, N.Y.; Arthur R. Theis, assistant chief engineer, Louisiana Department of Public Works; William W. Woodhouse, Jr., professor of soil science at North Carolina State University; and Donald J. Zinn, director of the National Wildlife Federation.

Another Beaver Story

A colony of flat-tailed engineers appears to be challenging the endurance of the Virginia Department of Highways by rebuilding the same twig and mud dam across Dewey Creek as often as road crews destroy it. The highway men fear that the water backed up by the 18-inch high dam could wash out the foundation of Possum Point Road, just a few yards away.

The highway supervisor for the Dumfries area of Prince William County has had to place 3 of his maintenance men on regular duty tearing down the dam as often as 3 times a week. After 6 months, local residents have begun to wonder which side needs the most help to resolve this environmental impasse—and many are siding with the beavers.

Panama Pipeline

A cross-country oil pipeline is under consideration by the government of Panama, which has had a U.S. firm make a study of the possibility. Panama's Minister of Industry explained that the study was undertaken because the Panama Canal is too small to accommodate large oil tankers.